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THE LUMINESCENCE OF DIAMOND—I

Sir C. V. RAMAN

1. Introduction

NO less than seventy-five distinct papers which concerned themselves with the structure and properties of diamond were communicated by the present writer and his collaborators and published in the *Proceedings* of the Indian Academy of Sciences between the years 1934 and 1948. Review articles surveying the work of the latter part of this period appeared from time to time in the pages of *Current Science*. Investigations on the diamond have once again been taken up and fresh results have been reported in the *Proceedings* of the Academy for August 1950.* It appears appropriate in these circumstances to give an account of this recent work in the light of the earlier investigations. In doing so, we shall not trouble to quote literature references, since the interested reader will find a complete bibliography classified under various headings on pages 269 to 287 of the *Proceedings* of the Academy for December 1948.

When the phenomenon of the luminescence of diamond first came under the notice of the present writer in the year 1930, it was not regarded as a subject offering scope for research. Actually, it presented itself as an impediment to the researches then in progress which had for their object the spectroscopic study of the scattering of light in diamond with a view to discover the nature of the *complete vibration spectrum* of that substance. The realisation of

* *Memoirs of the Raman Research Institute*, No. 9. "The Luminescence of Diamond and its Relation to Crystal Structure," by Sir C. V. Raman and A. Jayaraman.

this aim had indeed to wait for many years until some non-luminescent diamonds came into the possession of the writer. That the luminescence was itself a phenomenon worthy of study did not suggest itself till the year 1940 when Mr. P. G. N. Nayar took up the problem at the instigation of the writer. It soon became apparent that a most fertile field of research awaited exploration.

The first of the six pictures in the figure shows a group of 88 South African diamonds set within a circlet of pearls as seen by daylight. The remaining five pictures show the same diamonds made visible by their emission when irradiated by sunlight filtered through a plate of nickel-oxide glass. The five pictures

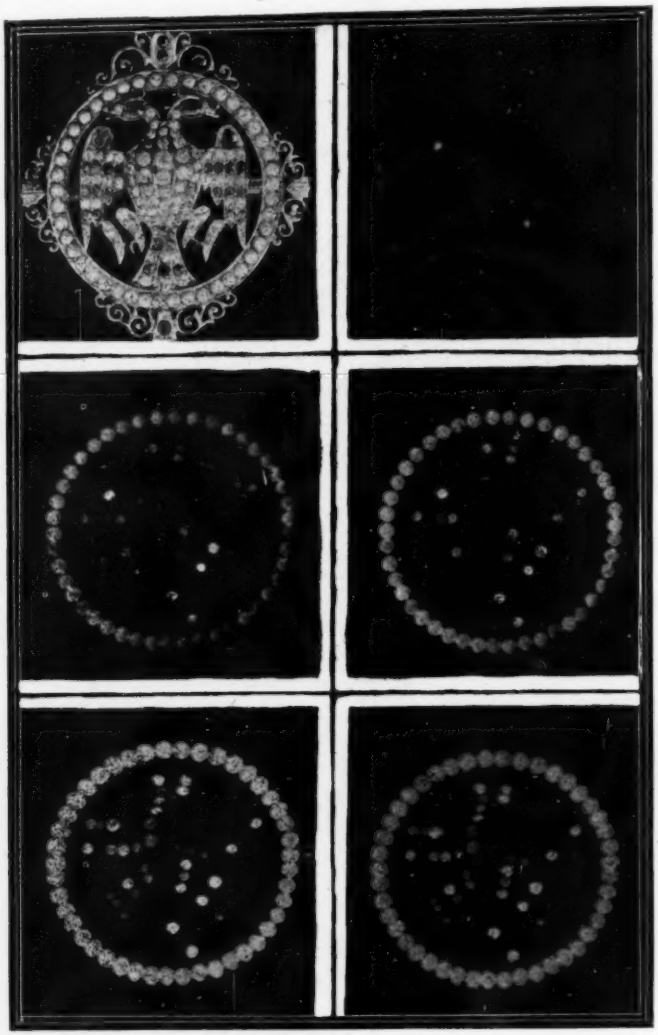

FIG. 1
Luminescence of South African diamonds

The photographs reproduced in Fig. 1 exhibit one of the remarkable features of the luminescence of diamond, namely, the enormous variations in its intensity. were recorded respectively with exposures of 5 seconds, 15 seconds, 30 seconds, 120 seconds and

1,800 seconds. Only in the last and most heavily exposed picture is it possible to recognise the original pattern seen by daylight.

Equally noteworthy are the variations in the colour of the luminescence of diamond. While the majority of clear white diamonds show a blue luminescence, others exhibit a greenish-blue, green or greenish-yellow luminescence under ultra-violet irradiation, while a small minority are definitely non-luminescent. In June 1942, the writer had the opportunity of examining a great many diamonds of Indian origin at Panna, and was much impressed by the fact that all the 52 diamonds of the highest quality and of great size in the necklace owned by the Maharaja of Panna were blue-luminescent, though the intensity of such luminescence varied largely. During a visit by the present writer to London in May 1948, the opportunity arose of examining the luminescence of a very large number of diamonds of high grade from the Congo area in their natural form as crystals. The stones had been sorted and arranged in cages in the order of their excellence as judged by their water and freedom from colour. Each cage contained some fifty to sixty crystals. All the diamonds without exception from the first six cages showed a luminescence of blue colour. Examples of green or yellow luminescence were very few even in the cages containing the lower grades, a blue or bluish-green luminescence being by far the commonest effect observed. The similarity between these results and those observed with the Panna diamonds in June 1942 was so striking that one could scarcely doubt that the blue luminescence was a characteristic property of diamond of the first quality.

2. Luminescence and Absorption Spectra

Examination of the spectrum of the light emitted by luminescent diamonds reveals the cause of the variations in its colour. In Fig. 2 are reproduced a set of seven pictures recorded in some recent studies by Mr. A. Jayaraman. The first of these pictures is that of a typical

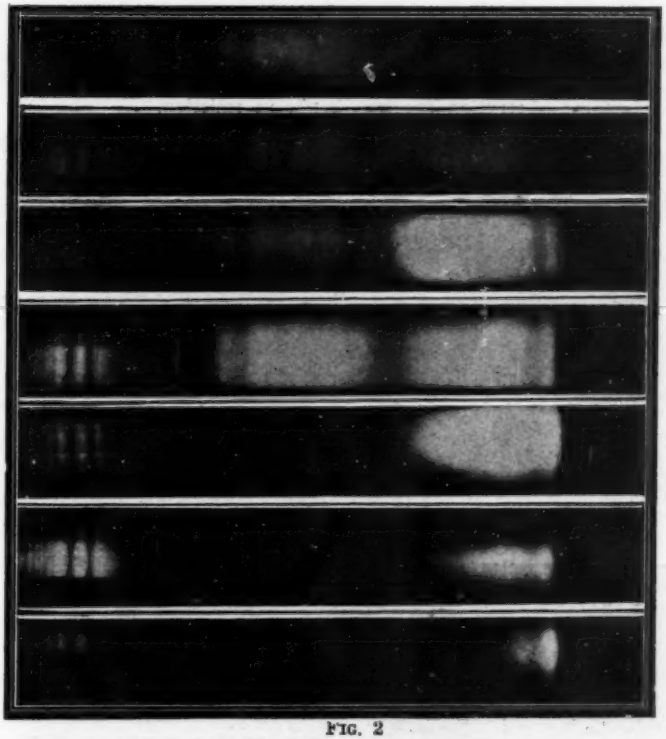

FIG. 2

Luminescence spectra of diamonds

(*a*) Blue. (*b*) Bluish green, (*c*) Green, (*d*) Bluish white, (*e*) Greenish yellow, (*f*) Yellow, (*g*) Orange.

blue-luminescent diamond, while the third spectrum is that of a diamond exhibiting an intense green luminescence. These types of emission were those very thoroughly studied by Mr. P. G. N. Nayar and Miss Anna Mani respectively. It is evident that the second and fourth spectra in the figure are superpositions in different intensity ratios of the blue and green types of luminescence. The last three spectra in the figure represent other types of luminescence which are less common but are also of great interest. It would seem that they arise from a progressive extinction of the shorter wave-lengths in the second or green type of spectrum with a consequent approach of the colour of the luminescence to a pure yellow or orange.

The spectra reproduced in Fig. 2 were recorded with the diamonds held at room temperatures. Lowering the temperature of the crystal to that of liquid air results in the sharpening of the bands, whereby the true character of the spectra stands clearly revealed. Lowering of the temperature has an analogous effect on the corresponding absorption spectra exhibited by the same diamond. Inter-comparison of the emission and absorption by the same diamond at low temperatures reveals the remarkable connections between the two. These features are apparent from Figs. 3, 4 and 5 reproduced from the papers of Mr. P. G. N. Nayar and Anna Mani. In Fig. 3, the upper of the two spectrograms represents the emission spectrum and the lower the absorption spectrum. The former exhibits the bright lines at λ 4152 and λ 5032 characteristic of the blue and green types of luminescence respectively. The lower spectrum, on the other hand, exhibits dark lines in absorption at the same wave-lengths. It will be seen from the same figure that the emissions at λ 4152 and λ5032 are accompanied by subsidiary bands towards the longer wave-lengths. In absorption, on the other hand, the subsidiary bands appear towards shorter wave-lengths. The subsidiary bands in emission and absorption exhibit mirror image symmetry about λ 4152 and λ 5032 as the case may be, their frequency shifts with respect to these being equal and opposite. This is clearly seen from Fig. 4 in the case of λ 5032 and from Fig. 5 in the case of λ 4152. In the latter figure, the absorption spectrum has been reversed so as to exhibit the mirror image symmetry about λ 4152 line by the coincidence of the dark bands in absorption with the bright bands in emission.

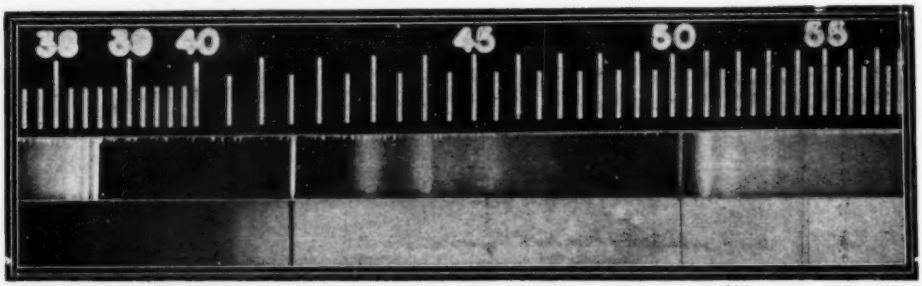

FIG. 3

The fluorescence and absorption spectra of diamond.

The relationship between the emission and absorption spectra of diamond is also illustrated in a striking manner by studying the effect on the intensity of the luminescence of exciting the same with monochromatic light the wave-length of which can be altered. Anna Mani carried

FIG. 4

The 5032 system in emission and absorption at liquid air temperature showing mirror image symmetry

out a series of experiments of this kind and found that the intensity of the blue luminescence passes through a series of maxima and minima when the exciting radiation is on the short wave-length side of λ 4152 and is gradually shifted towards that wave-length. It reaches a large maximum when the exciting band coincides with λ 4152 and then drops suddenly to a small value when shifted to greater wave-lengths. Similar effects in respect of the green luminescence are noticed when the exciting radiation lies on one side or the other of the principal absorption at λ 5032 which goes hand in hand with that luminescence. The facts recited show that the absorption and emission centred at λ 4152 and λ 5032 respectively represent electronic transitions, while the subsidiary bands represent the vibrational transitions of the crystal lattice which are coupled with these electronic transitions.

3. The Lattice Spectrum of Diamond

The foregoing interpretation of the observed facts finds confirmation in the agreement of the frequency differences (positive and negative respectively) derived from the luminescence and absorption spectra with the lattice frequencies in diamond as determined from studies on the scattering of light and on the infra-red absorption in the substance. The electronic absorption and emission lines are diffuse at room temperatures and exhibit a readily observable width and structure when it is cooled down to liquid air temperature. This introduces some uncertainties in the lattice frequencies as deduced from the studies on luminescence or the corresponding absorption. Such uncertainties are even greater in the case of the green luminescence, the λ 5032 line being diffuse even at

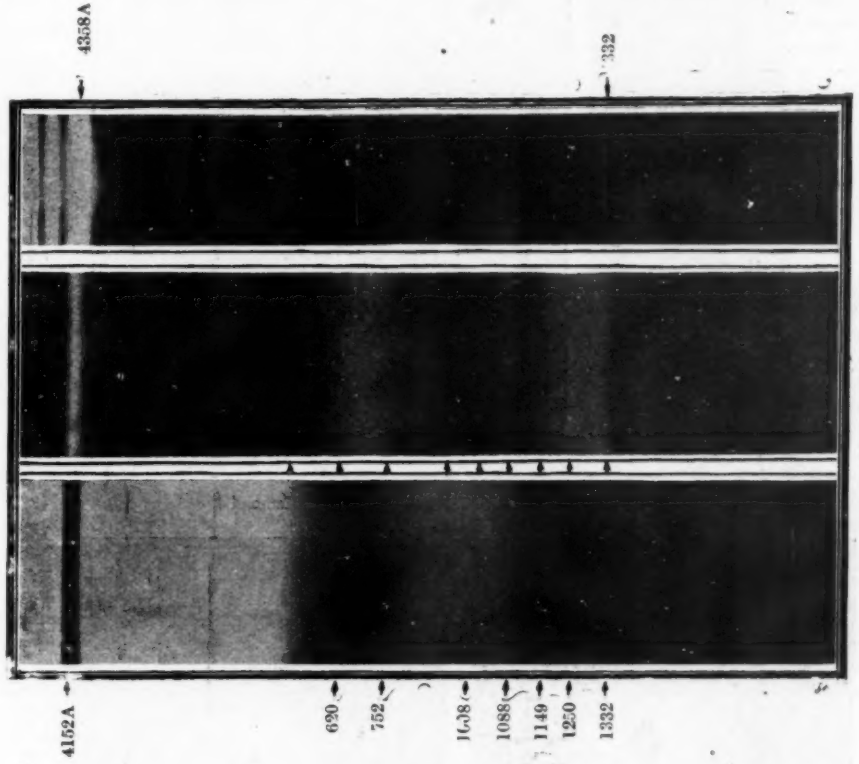

FIG. 5

(a) Raman spectrum of diamond. *(b)* Emission spectrum and *(c)* Absorption spectrum (reversed)

liquid air temperature. Nevertheless, the results are sufficiently definite to give us an indication of the nature of the vibration spectrum of the diamond lattice. Particularly remarkable is the appearance in the emission spectrum of blue luminescence, of a series of well-defined bands. These are shown in Fig. 6 taken from a paper by K. G. Ramanathan. Their positions are marked in the figure and their sharpness is evident from the accompanying microphotometer record. As already remarked, the finite width of the λ 4152 line sets a limit to the sharpness with which the vibrational transitions are recorded. The sharpness is even less satisfactory in the case of the λ 5032 line and the accompanying vibrational transitions. Hence, the evidence from the luminescence spectra regarding the discrete character of the lattice

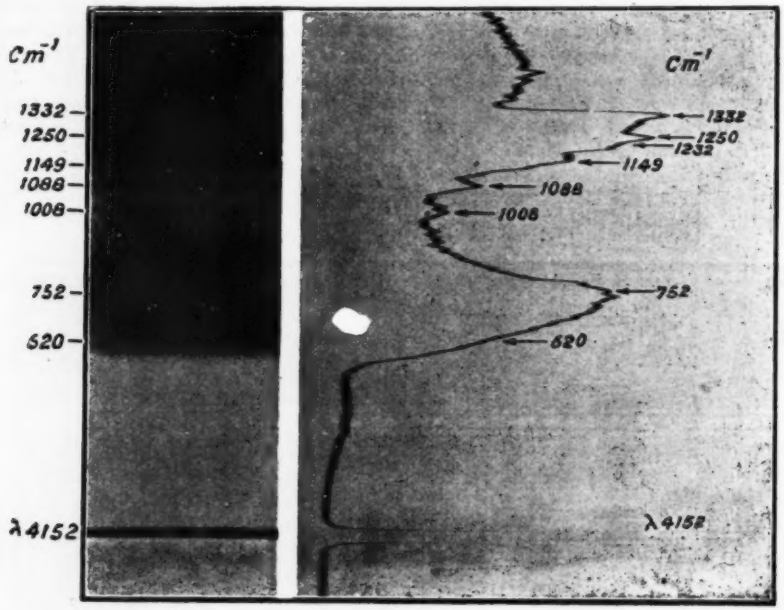

FIG. 6
The emission spectrum of blue-luminescent diamond

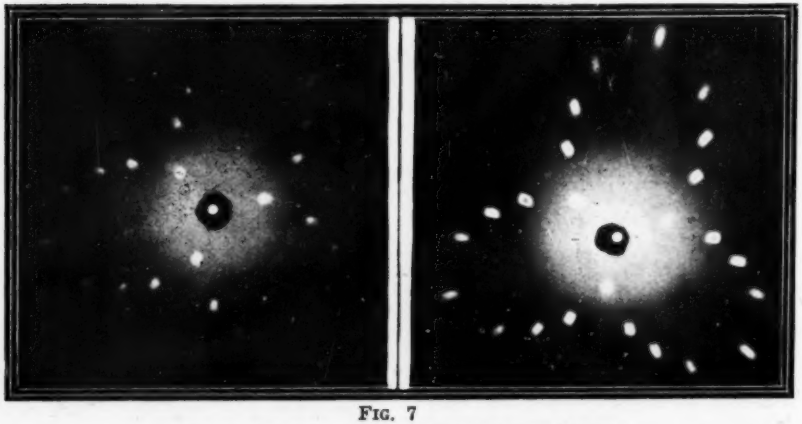

FIG. 7
Laue photographs of two blue-fluorescent diamonds

vibration spectrum of diamond must be regarded as indicative rather than as demonstrative. The real proof of the discrete line-character of the lattice vibration spectrum of diamond comes from the studies on light scattering, where the sharpness of the recorded lines is determined by the monochromatism of the incident light which is very high.

The spectroscopic facts set forth above make it clear that in spite of the enormous variations in the intensity and colour of the luminescence of diamond, we are dealing with a well-defined phenomenon namely, certain electronic transitions and associated vibrational transitions, the positions of which do not vary either with the particular specimen or with the locality of its origin. What varies is the intensity of these transitions. Thus, we are naturally led to infer that the luminescence is a phenomenon characteristic of the diamond itself, and that the variations observed arise from corresponding variations in the fine structure of the crystal. This conclusion is powerfully reinforced by X-ray studies especially those made and reported in various papers by Dr. G. N. Ramachandran. It is found that there is a precise quantitative correlation between the strength of the blue luminescence exhibited by diamonds with the intensity of the X-ray reflections, both of the Laue and the Bragg types, given by their crystal planes. This is illustrated for the Laue reflections in Fig. 7. The two photographs reproduced were recorded with equal exposure, with two diamonds of equal thickness but differing in the intensities of their blue luminescence. It is seen that the Laue reflections of the two diamonds differ greatly in their intensity. Dr. G. N. Ramachandran has also shown that the angular divergence of the Bragg reflection given by the diamond with monochromatic X-rays is least for faintly blue-luminescent diamonds and increases with the intensity of that type of luminescence. In other words, the former represent the nearest approach to an ideally perfect crystal structure.

(To be continued)

MEMORIAL TO LORD RUTHERFORD

THE Council of the Royal Society have issued an appeal for financial support for the creation of a suitable memorial to the late Lord Rutherford of Nelson.

It is universally acknowledged that Lord Rutherford was one of the foremost figures in twentieth century science. Our present knowledge of the structure of the atom is, to a very large extent, due to the researches carried out under his inspiring leadership. Together with Soddy, he put forward the conceptions of radioactive series and of isotopes. His classical experiments on the scattering of α-particles led to the nuclear model of the atom. This spurred on Bohr, then working with Rutherford, to formulate his picture of the atom as being composed of stationary quantum states. The first artificial transmutation was observed by Rutherford by bombarding nitrogen nuclei with α-particles. This technique, applied to other light elements in various laboratories of the world, finally culminated in the discovery of the neutron by Chadwick in Rutherford's own laboratory.

It was again under Rutherford's direction that Cockcroft and Walton achieved the first atomic transmutation by means of artificially accelerated particles. This experiment not only opened up a new method of disintegrating atoms, but also served to demonstrate the validity of Einstein's mass-energy relation and to point out the possibility of the transformation of matter into energy. Feather, working with Rutherford, was the first to show that neutrons could produce nuclear transmutations, an observation, which in the hands of Fermi and collaborators in Rome, and Hahn and others in Berlin, led to the discovery of nuclear fission. The further development of this resulting in the release of "atomic energy" is recent history. We do not yet know the full potentialities of this newly discovered source of energy, which, if harnessed for the good of humanity, may perhaps usher in a new era in civilisation.

It is proposed that the memorial should take two forms:

1. Rutherford Scholarships, tenable for three years to be awarded to post-graduate students within the Commonwealth, for research in natural sciences with a preference for Experimental Physics, the scholar to carry out his research in an Institution in some part of the Commonwealth other than that in which he graduated.
2. A Rutherford Memorial Lecture to be delivered at intervals at selected centres in the Commonwealth, at least one in three to be given in New Zealand, where Rutherford was born.

Since a substantial endowment fund will be needed for these purposes, the Royal Society have sent out an appeal for contributions to the fund and we heartily endorse this appeal. Contributions may be sent to the Rutherford Memorial Committee, The Royal Society, Burlington House, London W. 1, England.

EDITOR.

HORA'S SATPURA HYPOTHESIS[1]

An Aspect of Indian Biogeography

IT is fortunate that within a few months of each other, two important contributions[2] on biogeography, independently conceived and executed in each case by a team of scientists, have been published recently, enabling one to check his results against the findings of the other group of workers. One published in September 1949 in the U.S.A. deals with "Biogeography of the Pleistocene" by Dr. Edward S. Deevey, Jr. of the Yale University. This is one of the 12 contributions on "Pleistocene Research" and deals mostly with the problems of Europe and North America. The second contribution is more restricted in its scope, but the "Symposium on the Satpura Hypothesis of the Distribution of Malayan Fauna and Flora to Peninsular India", published at Calcutta in November-December 1949, contains a series of 21 articles.

Dr. Deevey points out that "from the standpoint of Pleistocene biogeography, North America and Europe resemble each other closely, and differ in the character of their problems rather sharply from Africa, Southeastern Asia, and South America" (p. 1404). Though admittedly the characters of the problems in the two vast regions are different, the fundamental scientific approach for elucidating these problems appears to be the same in both cases. For instance, in both the contributions, attention has been paid not only to the present-day distribution of animals but also to geology, stratigraphy, climatology and glaciology in so far as they have influenced the pattern of distribution in the past ages. In this review of the two contributions, it is intended to apply some of the principles enunciated in the Symposium on "Pleistocene Research" to the findings contained in the Symposium on the "Satpura Hypothesis".

Certain Views set forth in the "Pleistocene Research" Symposium

Effects of Glaciation.—Considering the problems of North America and Europe, Deevey stated (p. 1404):

> "As would be expected, the two continents where continental glaciation occurred on the most extensive scale differ from the rest of the world where glaciation was confined to high mountains, and where the more spectacular climatic changes during the pleistocene were in the direction of increased precipitation rather than refrigeration".

In dealing with "Problems of Pleistocene Stratigraphy" and in this connection with the "stratigraphy of areas remote from and only indirectly associated with Glaciation", Ray[1] (p. 1469) observed:

> "In areas far from glaciated regions where there are no direct means of correlating events with ice advances and recessions, the problems of Pleistocene stratigraphy are manifold and difficult. Their solution must be based ultimately on climatic fluctuations which in these areas were generally not so large nor so important an environmental factor as in glaciated areas or the areas peripheral to glaciers. These climatic fluctuations appear to have produced either intensified or lessened prcipitation along with temperature changes. Cool-moist periods are generally correlated with glacial ages, warm-dry with interglacial".

Other observations bearing on the Satpura Hypothesis.—Beside the effect of glaciation in areas remote from it, there are five other considerations which must also be borne in mind in evaluating the Satpura Hypothesis. These are as follows:—

(i) It is generally recognised that there was a sequence of four major glacial ages, separated by interglacial ages as warm or warmer than the present.

(The major glaciations separated by interglacials relate to what is today the temperate zones of the northern hemisphere. This rhythm has not been firmly established yet anywhere else. *F. E. Zeuner*).

(ii) In Pleistocene stratigraphical work, it is generally assumed that climatic fluctuations were broadly synchronous throughout the world.

(You rightly say that it is *assumed* that climatic fluctuations were broadly synchronous throughout the world. It is important to remember that this is an

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1. This review was sent to Professor F. E. Zeuner for comments and suggestions. His observations are given in the body of the paper in brackets or as foot notes. The reviewer is grateful to him for his kindness and courtesy.

2. "Pleistocene Research," *Bull. Geol. Soc. America*, Sept. 1949, **10**, No. 9, 1305-1525.

"Satpura Hypothesis," *Proc. Nat. Inst. Sci. India*, Nov.-Dec. 1949, **15**, No. 8, 309-422.

1. Ray, L. L., "Problems of Pleistocene Stratigraphy," *Bull. Geol. Soc. America*, 1949, **60**, 1463-74.

assumption and that it has never been proved. This refers in particular to glaciations in the northern and southern hemispheres respectively. Personally I think that it is more likely than not that they were synchronous, but we must be honest and admit that it has not been proved, in spite of all the sweeping statements to this effect. *F. E. Zeuner*).

(iii) Climatic fluctuations during the Pleistocene caused fluctuations of sea level in response to the amount of water withdrawn from the oceans and temporarily held in glaciers on the land.

(*iv*) Besides the normal crustal movements throughout the world, crustal warping and rebound in glaciated and peripheral regions, occasioned by the loading and unloading of the crust with ice, also occurred.

(*v*) Relict floras and faunas generally indicate that the present-day climatic conditions of their habitats are more or less similar to those prevailing in the past ages in those specified areas.

Ecological Specificity of Animals : Biological and Physical Environment.—Besides the above considerations, it is essential in biogeographical studies "to evaluate qualitatively the importance of the adaptations to environmental changes produced through climatic fluctuations, it is essential to know, (1) the magnitude of these fluctuations necessary to change the environment significantly, and (2) the relative sensitivity of fauna, flora, soil, erosive processes, and other factors to these changes. Until more is known of the relative sensitivity of the various indicators of climatic fluctuations, interpretation of the past can be only subjective". (Ray, p. 1470).

It is true, as pointed out by Ray (p. 1469) that "changes in floral assemblages will be correlative with faunal changes", and that "commonly migrations in altitude of the fauna is the only indication of climatic change unless extinction of the species is known". (Ray, p. 1470). It would thus appear that "all life, the environment, and the attendant physical processes were influenced by the sequence of climatic fluctuations on which Pleistocene stratigraphy ultimately must be based" (Ray, p. 1471).

Smith[1] (p. 1486), in dealing with the effects of Pleistocene climatic changes, has remarked:

"Climatic effects in nonglaciated areas are recorded in two main types of phenomena: biologic and physical. Investigations of the biologic phenomena, involving the migration and progressive modification of floras and faunas, are fundamental and are dealt with elsewhere in this series of papers. The evidence provided by purely physical phenomena complements the biologic record and, in many places where fossils are absent or inadequate, provides the primary basis for interpretation of former climatic changes. Of the various physical effects related to climatic fluctuations, three are of particular interest for the problems which they present and for their significance in the interpretation of the Pleistocene record: (1) eolian phenomena, including dune building, loess deposition, and sand blasting; (2) frost phenomena, including mechanical weathering, ground-ice development, solifluction, and associated processes; and (3) stream terracing produced by alterations between aggradation and degradation".

Deevey's fundamental conceptions and principles.—In his valuable contribution, Deevey has referred to certain biological deductions and principles which are well worth reiteration. These are:

1. Species spread much or little according, first, to their inherent abilities to disperse, and second, to the intensity of the geographic barriers opposing them.
2. Existing ranges of species and of larger groups are the product not of existing geographic conditions, but of all geographic conditions obtaining throughout the history of the species or stock. It is fallacious therefore, to assume that the existing distribution pattern of the species is as old as the species itself, or as the genus or family to which it belongs. It is true, however, that in the case of species that arose in the pre-Pleistocene period, during the Pleistocene "there has been sufficient time, and sufficient transfiguration of geography, for the pre-Pleistocene distribution pattern to be completely transformed in a very large number of cases".
3. Pleistocene biogeographical studies are bipolar. "At one pole are grouped ecology, systematic botany and zoology, the study of evolution, and related biologic disciplines. At the other pole are grouped the Earth sciences, all of which are concerned in understanding the geography of the Pleistocene". Pleistocene research is,

1. Smith, H. T. U., "Physical effects of Pleistocene climatic changes in non-glaciated areas : eolian phenomena, frost action, and stream terracing," *Bull. Geol. Soc. America*, 1949, **60**, 1485-1515.

however, one integrated subject, pursued in equal partnership by biologists and geologists in the widest sense.

4. "A few kinds of animals, and perhaps a few plants really seem to require continuous land connection for their dispersal, and it is impossible to imagine their crossing a water gap".
5. Recolonization is not so much a matter of accident as of ecological succession. As soon as living conditions are suitable for the survival of an animal species, that species appears.

In order to explain his fundamental position on matters of biogeography, Deevey has set forth the following guiding principles:—

1. Biogeography should deal with species, not with families or orders.[1]
2. The age of a distribution pattern is not necessarily the same as the age of a species.
3. All distributions of species are taken to be of Pleistocene date in the absence of a good proof that they are older.[2]
4. The present range of the parent species is not necessarily the place of origin of the off-spring species.
5. Modern genetic and ecologic theories are in full agreement that species do not arise from other species except through reproductive isolation of segments of a parental population, and that in sexually reproducing animals and plants the reproductive isolation is ordinarily achieved through geographic segregation. . . . Nearly all well-studied cases of sub-speciation and speciation point to the Pleistocene as the time of such previous isolation, and the occurrence of closely related forms in the same area is therefore attributed to post-Pleistocene alterations in geography and in biogography.

1. This is undoubtedly an over-generalisation. What the author really means is that we should work with as detailed information as possible and therefore descend to the species and sub-species level wherever possible. This is a matter-of-course for every serious worker and has always been so in biogeography. On the other hand, there are problems which are peculiar to the higher systematic units. As an example, the distribution of palms or of reef-building corals can, and ought to be, considered on the level of families or orders.—*F. E. Zeuner.*

2. This is a very narrow outlook indeed, borne from the consideration of glaciated and periglacial areas. In other parts of the world it would be foolish to make any such dogmatic assumption and in recent years much evidence has been accumulating indicating that both species themselves and distribution patterns in some countries are often very much older than the Pleistocene. —*F. E. Zeuner.*

Application of the above considerations to the Satpura Hypothesis

Distribution and Ecology of the Present-day Fauna and Flora.—Of the 21 papers, included in the Symposium on the Satpura Hypothesis, as many as 10 papers deal with the distribution of animals (Mammals, Birds, Chelonians, Snakes, Lizards, Fishes and Annelids) and 2 with plants (Paresnath Hill and Bailadila Range). The authors of these papers, dealing with races, sub-species, species and genera, have conclusively established that—

(*i*) There is a considerable element of the so-called Malayan fauna and flora in the Peninsula of India and Ceylon.

(*ii*) The route of migration of this element lay across the Garo-Rajmahal Gap (from the Assam Hills and Eastern Himalayas on the one hand and the Plateau of Chota Nagpur on the other).

(*iii*) From the Chota Nagpur Plateau, there are possibilities of two routes of migrations — Vindhya-Satpura-Western Ghats route and Orissa Hills—Eastern Ghats-Western Ghats route.

(*iv*) The specialized flora and fauna are adapted to an evergreen biotope with considerable annual rainfall, about 100 inches or so, spread over a greater part of the year.

(*v*) Altitudinal distribution of plants and animals is not so much governed by temperature as by annual precipitation and relative humidity throughout the year.

(*vi*) The present-day distribution patterns of various species are governed by ecological considerations and along the routes, wherever and whenever suitable habitats have been investigated, fresh evidence of such migrations has been established.

(*vii*) In the case of birds and fishes, it has been opined that the present element in the hills of Peninsular India, is the result of more than one wave of migration.

(*viii*) The compositions and inter-relationships of the floras and faunas indicate that migrations of terrestrial forms occurred mostly during the Pleistocene, whereas the dispersal of the

aquatic forms has been going on from much earlier periods.

Climatology.—The two articles dealing with climates have also emphasized the ecological specificity of the fauna and flora being mostly responsible for their dispersal in the past and the present-day distribution pattern. It has also been concluded that during the pluvial periods increased precipitation produced favourable conditions for the dispersal of plants which later contributed to the dispersal of land animals. During the arid or inter-glacial periods, the floras and faunas became restricted to certain suitable areas and thus isolated in patches. This inhibited inter-breeding of isolated stocks, thereby causing speciation. Sometimes the species, thus isolated, had sufficient time to be differentiated and thereby escaped being swamped over by the succeeding waves of migrations while in slow-evolving forms any such differentiation may have been swamped over by the next wave thereby causing reversion to the ancestral stock. The indications of such happenings are many though they have not yet been intensively studied and properly elucidated.

Geological Considerations.—Auden, on p. 337 of his article entitled "A Geological Discussion on the Satpura Hypothesis and Garo-Rajmahal Gap", gives the following as the primary factors involved in the faunal migration:—

"(1) A secular climatic change, involving 4 or 5 glaciations, with interglacial periods which were probably cooler than any climate experienced now in central and southern India.

"(2) The glaciers during the period of ice advance reached much lower down the valleys, and glacial boulder beds have been found recently even to be incorporated within the Siwalik succession of northern India.

"(3) Not only did the glaciers reach to lower levels as a consequence of colder climate, but during the Pleistocene the montane zone must itself have been at smaller elevations. The influence of the glaciation on the climate of the Peninsula must therefore be considered from the dual point of view of an intrinsically colder climate in the mountains and the existence of glaciers at lesser elevations than even the present heights of maximum ice advance indicate. During the phases of maximum glacier advance the snouts of the glaciers may have been, from combined climatic and isostatic causes, some 6,000 to 8,000 feet lower than at the present time.

"(4) It is difficult to avoid the conclusion that these conditions in the montane and bordering zones of northern India must have resulted in a diminution of the temperature in the region now represented by the Satpura and Vindhyan ranges. A lowering of the mean annual temperature in these regions of only 20° to 30° F.,[1] which could still be considerably above the freezing temperature of the glaciated region to the north, would permit much greater run-off and larger river discharges for an equivalent rainfall.

"(5) The greater relative humidity and higher river discharges would perhaps be sufficient explanation for the migrations of the faunas postulated."

With regard to the present Garo-Rajmahal Gap, Auden (pp. 315-340) first reviews the sequence of geological events which have taken place in northern India since the Gondwana period. He lays stress on various unconformities, in particular that at the base of the Deccan Traps, on crustal tension during the period of eruption of the traps, and on uplift taking place concomitantly with erosion which vitiates direct calculation of former elevations from the amount of rock removed by erosion. After concluding that there is little geological evidence for supposing that any major range formerly existed in mid-Tertiary times along the present Vindhyan-Satpura trend, he discusses the climatic factors which may have contributed towards an increased percentage of run-off from a given precipitation. As regards the Garo-Rajmahal Gap, he gives the following tentative conclusions:—

"It is considered probable that a connection did arise between the Shillong plateau and the peninsula during the Miocene and that the final break causing the present Garo-Rajmahal Gap took place during the Pleistocene along a N.W.-S.E. line of fracture extending from the Darjeeling-Himalaya to Comilla and Chittagong. Consequently, it is necessary to suppose that while the central part of the peninsula was undergoing mild uplift during the Pleistocene,

1. It seems to me that the actual amount is likely to have been much less than this. Nevertheless any lowering of the temperature will reduce evaporation and, therefore, increase the run-off even without a rise in precipitation.—*F. E. Zeuner.*

the bordering areas of Cutch, Saurashtra, and northern Bengal were subjected to depression".

On the other hand, Dey (p. 409) in a short article on "The Age of the Bengal Gap", has considered it "impossible, on available evidence, to accept the idea of a belt of hills across the Bengal Gap, Chota Nagpur, etc., within the time range of living animal species. The vast depression of temperature during the glaciation of the Himalayas (glaciers certainly come below 5,500 ft. and possibly well below 4,000 ft., in the Kangra Himalayas) seems to provide a more reasonable alternative". Dey's contentions are not borne out by the biogeographical researches reported in the Symposium and, as indicated in this review, the gap did not exist at least from the early Tertiary times to the late Pleistocene period.[1]

In any Pleistocene research, the evidence from stratigraphy can be very confusing and in such cases biogeography can be extremely useful. The evidence of biogeography recorded in the Symposium on the "Satpura Hypothesis" is clearly in favour of a hilly track bridging up the gap between the Shillong plateau and the Chota Nagpur plateau. As regards the height of the hills that filled the gap from the Miocene to the Pleistocene periods, the position is not quite clear, but the following account of "Dunn's Uplifts in Chota Nagpur" after Auden (p. 328) is very significant in this connection:—

> "Dunn has concluded that at the latitude of Rajmahal (25°) the crust has undergone little change in elevation since the Jurassic, and has acted as a hinge zone. North of the hinge there has been progressive down-warping in response to the Miocene and later Himalayan movements, which has allowed the accumulation of over 6,000 feet of freshwater alluvial sediment in the north Bihar basin. Nearly the whole pile of these sediments now lies below sea-level (Wadia and Auden, 1939, pp. 133-35). South of this hinge there has been progressive uplift, which has been summarized by Dunn as follows (1939, p. 141):—
>
> 1. Uplift of 1,000 feet of an early tertiary peneplane, with a downward tilt to the north-east.
> 2. Middle or Upper Tertiary uplift of 1,000 feet reaching a maximum in the Ranchi Plateau, with downward tilt to the north-east.
> 3. Further uplift of 300 feet.
> 4. Final uplift of 400 feet.
>
> The total uplift in the Chota Nagpur area along latitude 23° was therefore of the order of 2,500 to 2,700 feet, with nil movement along latitude 25°. Since this uplift has been taking place during the Tertiary and Pleistocene, it is evident that in early Tertiary times the land was at a lower elevation, and there is not much support for the idea of a major range existing to account for the migration of faunas".

In view of the fact that during the pluvial periods, when the temperatures were considerably lower and the precipitations higher, low hills provided the same ecological conditions for the migrations of faunas as do the higher hills of the present-day topography of India.

A summary of the above results would indicate that:

(i) In the early Tertiaries, there were lowlands in the region of the Garo-Rajmahal gap.

(ii) This gap began to be filled up in the Miocene and progressively continued to be filled up even upto the early Pleistocene.

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1. I agree that there is little geological evidence for a major range of hills. I do think, however, that Dey's views have a fairly strong background from the geological evidence and that it is no use overlooking this fact. The arguments having been taken from two different disciplines are inevitably becoming very involved and it seems to me that we have to be very careful and try to steer a straight course instead of arguing in a circle. What I mean is this. Biogeographical evidence of actual distribution of species, etc., calls for an explanation. The easiest explanation would be the former existence of a range of hills across the Bergal Gap. Geological evidence is not on the whole in favour of this explanation. This I think is the matter in a nutshell. It is necessary to try to find a way out of this deadlock. One way is to construct a connection *via* the Himalayas and Rajputana. Another is to change the climate in certain ways so as to get the species through Bengal without requiring a mountain range, and there are other possibilities. This is, of course, the very reason why you have been encouraging a discussion of the whole Satpura Hypothesis and I think that a lot of good work has been done as a result of this, but I feel that we must not go so far as to regard the biogeographical distribution as evidence that a mountain range across the gap existed. The problem is certainly quite as serious, and your merit in having drawn attention to is quite as great, no matter what the ultimate explanation of this interesting phenomenon will be. Quite honestly I do not believe that we have found the answer yet.—*F. E. Zeuner.*

(iii) The present gap appeared probably in the late Pleistocene, about the same time as the dismemberment of the Indo-Brahm or the Siwalik River.

(iv) During the pluvial periods when the sea level fell by 100 to 200 meters, the height of the hills relative to the level of the sea increased by the same figure and thereby induced heavier precipitation in the hilly areas.[1]

(v) During the Pleistocene when the central part of the Peninsula was undergoing mild uplift, the flora and fauna became dispersed to the hills to the north and south of the Vindhya-Satpura Trend.

(vi) The discontinuity of the Vindhya-Satpura Trend in the region of the Garo-Rajmahal Gap and in the regions of Cutch and Saurashtra occurred during the Pleistocene.

The Satpura Hypothesis

In the light of the findings contained in the two Symposia on biogeography, let us now study the Satpura Hypothesis in detail and indicate the lines along which further research should be carried out. Though in the Symposium, attention has mainly been paid to the distribution of Malayan fauna and flora to Peninsular India, the original proposition made in 1937 implied several other biogeographical considerations which may now be taken up. In 1937, it was stated:[2]

"As the Himalayas rose to a great height in the region of the isthmus (mostly the western part of the Assam Himalayas and the eastern part of the Nepal Himalayas) all the evidence concerning the north-eastward extension of the Indo-Brahm seems to have been obliterated. The uplift movment was probably most active in this region as we find practically all the highest peaks of the Himalayas clustered round this area. This differential movement which probably occurred late in the Miocene period, must have obliterated all traces of the eastward extension of the Indobrahm and also acted as a barrier between the eastern and the western Himalayan fishes. The new stock of specialized hill-stream fishes from the east, not finding means to cross this barrier, were deflected towards south-west along the Satpura Trend which probably at that period stretched across India as a pronounced range from Gujrat to Assam Himalayas. From Gujrat the hillstream fauna migrated towards the south along the Western Ghats and spread to the hills of the Peninsula in the extreme south".

Since the enunciation of the above hypothesis, considerable field work has been done on the distribution of fishes which is summarized in the Symposium. The distribution of specialized fishes along the southern face of the Himalayas has now been investigated by Shri. A. G. K. Menon, longitude by longitude, with very interesting results. As the results of his investigations are not yet published, I am indebted to him for the use of certain amount of this data here. In view of the advances that have been made during the last 13 years, it is necessary that the thesis should now be redefined so as to encourage more research being focussed on the problems arising out of it.

1. Southern China, mostly the Yunan region, was the cradle of the fauna of south-east Asia.
2. From the Yunan area, through earth movements, river captures, etc., the fauna spread to the east, south-west and south on the one hand and to the west, south-west and south on the other. This dispersal would seem to have commenced when the Philippines and islands of the Indo-Australian Archipelago north of the Weber Line were connected with the mainland in the east and Ceylon formed a part of India. At that period there would appear to have been a hilly connection between the Himalayan chain of mountains and the north African hills through Persia, Syria, Arabia and Scotra. This enabled the hill-stream fauna of south-east Asia to spread to Africa.
3. This dispersal probably commenced in the Eocene for in the Inter-trappean beds of Dongargaon, C.P., fossil remains of modern widely distributed species of sluggish waters have been found.
4. Judging from the fact that the island of Ceylon "was first severed during the Miocene epoch when a wide arm of the Tertiary sea extended across the southern parts of the peninsula" (Jacob, p. 341), the following biogeographical conclusions would seem irresistible:—
   (i) The dispersal of the hill-stream fishes of such genera as *Nemachilus*, *Garra*, *Tor*, etc., had taken place before the first appearance of the Ceylon-India

1. I do strongly support this point, that a eustatic drop in the sea-level of 600 feet is likely to have had quite considerable climatic implications.—*F. E. Zeuner.*

2. Hora, S. L., *Rec. Ind. Mus.*, 1937, **39**, 251-59.

gap and at that time the fauna was spreading to Africa along the Himalayas and to Ceylon along the Satpura Trend of mountains and the Western Ghats. It would imply that the Garo-Rajmahal Gap had already been filled up with low hills. This would thus be the Middle or Upper Tertiary period.

(*ii*) The next group of fishes, as indicative of the phase of dispersal, could be the remarkable torrential fishes of the family Homalopteridæ. This family is known practically from all over south-east Asia but its range does not extend to Ceylon or to Africa. In fact, along the Himalayas it does not extend westwards beyond longitude 85°. The inferences are:

(*a*) The dispersal of the Homalopteridæ commenced in the Upper Tertiaries when the hilly connection between India and Ceylon had already severed.

(*b*) The dispersal of the Malayan element from the eastern to the western Himalayas was checked in the Upper Tertiaries.

(*c*) The Garo-Rajmahal Gap had by that period a series of hills filling up the gap and with perennial torrential streams enabling the dispersal of the Homalopteridæ.

(*d*) The age of the dispersal of the Homalopteridæ is further confirmed by the speciation data.

5. Dispersal of animals and plants, aquatic, semi-aquatic and terrestrial, seems to have been facilitated by the pluvial periods of the Pleistocene glaciation; while the arid interglacial periods, isolated stocks of species and the segregation of stocks induced speciation. From the biogeographical data presented in the Symposium on the Satpura Hypothesis, the following inferences can be drawn:—

(*i*) The most direct connection permitting dispersal of hill-stream fishes from the Assam Hills to the Chota Nagpur plateau and the Vindhyas would certainly have been across the present Garo-Rajmahal gap. Geological evidence for a connection in late Tertiary times is somewhat equivocal, but it has been shown that major earth movements involving folding, overthrusting and tear faulting occurred in northern India during the Pleistocene, and would have been sufficient to have severed the bridge during the Pleistocene if, as some geologists consider, the bridge did exist. Reasons are given on page 329 of the Symposium which indicate that no connection probably existed in the Pleistocene between the Monghyr hills and the Nepal-Darjeeling Himalaya, but there may have been a connection along an extension of the Aravalli range.

(*ii*) There are successive waves of migrations of terrestrial animals corresponding to the numbers of the pluvial periods. Some work on the double and triple invasion has been done on fishes and birds but lot more remains to be done in all other groups of animals and plants.

(*iii*) The environmental facilities for dispersal could be more helpful to the terrestrial organisms but not to the same extent in regard to the aquatic forms, particularly specialized hill-stream fishes for the living of which perennial, torrential streams are essential.

One is able now to say with certainty that there is little evidence of the Ethiopian Element in the fauna of India while the circumstances of dispersal make it abundantly clear that there is a considerable Indian element in the fauna of Africa. The Symposium on the "Satpura Hypothesis" has broadened our outlook by permitting excursions into the realm of other sciences and the Symposium on "Pleistocene Research" has helped us to evaluate some of our views in a comparative way.

S. L. Hora.

PLUTO'S DIAMETER

THE Hale telescope has now been used visually to measure the apparent diameter of Pluto, at the Yerkes and McDonald Observatories, U.S.A. The planet is now believed to have a diameter 0·45 times that of the earth, placing it between Mars and Mercury in order of size in the solar system, and corresponding to a linear diameter of about 3,550 miles.

Its atmosphere is estimated to be less than 0·1 terrestrial atmosphere, and its mass slightly below 1/10 that of the earth.

—Courtesy of *Sky and Telescope*, October 1950.

THERMAL SCATTERING OF LIGHT IN BIREFRINGENT CRYSTALS

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THE existence of a genuine diffusion of light in a crystal was first recognised by Sir C. V. Raman.[1] The phenomenon arises from thermal agitation and may, therefore, be called thermal scattering. In Brillouin's theory,[2] the effect is ascribed to a "coherent reflection" of the light waves by the periodic stratifications produced by elastic waves of thermal origin in the crystal. The moving elastic waves would give rise to spectral shifts in the diffused light, which are in the nature of a Doppler effect. Since 1930, several investigators including Mandelstam, Landsberg and Leontowitsch,[3] Tamm,[4] Mueller,[5] Gross,[6] Bhatia and Krishnan,[7] and Kastler[8] have considered the theory of thermal scattering in crystals and the Doppler shifts occurring in them. The picture that is generally accepted at present is that in a crystal, whether birefringent or not, only three pairs of Doppler components occur, due respectively to the three types of elastic waves which are propagated with different velocities in any given direction. However, none of the authors have specifically considered the effect of birefrigence on the Doppler shifts. When this is examined in detail, the remarkable result emerges that there are, *in general*, not three but *twelve* Doppler components which can occur for a *birefringent* crystal. A short discussion of these new results is given below.

The expression for the magnitude of the shifts can easily be derived either on the basis of the quantum ideas or of the classical wave theory and the results are the same in either case. The Doppler shifts of the components of the scattered light depend on the velocity of the elastic wave as well as on the velocities of the incident and of the scattered light waves. Inside a birefringent crystal the incident light wave (i) divides itself into two waves which, in general, travel with different velocities and are polarised in mutually perpendicular planes. Similarly, the scattered wave (s) can travel with either of the velocities corresponding to the two states of polarisation of the wave. Let n_i (and n_s) be either of the two refractive indices of the crystal for the direction of incidence (and of scattering) and let λ be the wavelength of the incident light in vacuum. Then the conditions for coherence of phase of the scattering by the different volume elements lying on a particular stratification are (a) that the stratification should be normal to the plane of scattering and (b) that it should make angles θ_i and θ_s with the direction of incidence and that of scattering, such that

$$n_i \cos\theta_i = n_s \cos\theta_s \qquad (1)$$

$$\theta_i + \theta_s = \theta\,, \qquad (2)$$

where θ is the angle of scattering.

Further, the condition for the coherence of phase by volume elements lying on successive stratifications is:

$$\lambda_e = \frac{\lambda}{\sqrt{n_i^2 + n_s^2 - 2n_i n_s \cos\theta}} \qquad (3)$$

where λ_e is the wave-length of the elastic wave.

The Doppler frequency shifts $\Delta\nu$ of the components of the scattered radiation are the same as the frequency of the appropriate elastic waves, and are given by:

$$\frac{\Delta\nu}{\nu} = \pm \frac{v_e}{c}\sqrt{n_i^2 + n_s^2 - 2n_i n_s \cos\theta}\,, \qquad (4)$$

where c is the velocity of light in vacuum and v_e is the velocity of the elastic wave giving rise to scattering.

The characteristics of the scattered radiation may be analysed using the four fundamental equations (1) to (4). Since n_i and n_s can each take two values, there would be four pairs of values for (n_i, n_s) in equation (4) and consequently four values for λ_e and θ_i (and θ_s). Further, for a given direction of elastic wave normal, there are three types of elastic waves, each of which has a different velocity v_e. Thus, from equation (4), it is seen that there must, in general, be $3 \times 2 \times 2 = 12$ values for the frequency shifts ($\Delta\nu$). Therefore, the light scattered by a *birefringent* crystal, like calcite, must consist of *12 pairs of Doppler shifted components*. The possibility of such a large number of components has not been previously envisaged.

Equations (1) to (4) are symmetrical with respect to the suffixes i and s. Consequently, if the direction of incidence and that of scattering are interchanged, the frequency shifts of the components would remain unaltered.

For a given direction of incidence and of scattering, the two polarised incident light waves may be designated A and B and the two polarised scattered waves P and Q. Since either incident wave A or B can, in general, give rise to either of the scattered waves P or Q, the scattered radiation consists of four "species" P_A, Q_A, P_B and Q_B, each with a dis-

tinctive polarisation character. Each species will consist of 3 pairs of Doppler components due to the three elastic waves. By the use of a proper polarising device, such as a double image prism, in the incident path to separate A and B and another in the scattered path to separate P and Q one can independently study the four species of the scattered radiation.

In certain circumstances, it is possible that for some of the four species, $\cos\theta > n_j/n_s$ or n_s/n_i. Then the wave front of the elastic wave responsible for the scattering lies outside the internal angle between the directions of the incident and scattered wave normals. In such cases, the process of scattering must be regarded appropriately as "coherent refraction" of light wave by elastic waves.

If we consider scattering in the exact forward direction ($\theta = 0$), then the shifts for two Doppler components, say P_A and Q_B are zero, but the shifts for Q_A and P_B components are finite, but equal to each other. We thus have the strange result of a refraction without change of direction, but with change of frequency. In calcite, the magnitude of the shift is as large as 0·22 cm.$^{-1}$ when light of wavelength λ 2537 is incident perpendicular to the optic axis.

In the case of a single refracting medium $n_i = n_s = n$ and therefore, equation (4) reduces to the familiar expression

$$\frac{\Delta\nu}{\nu} = \pm \frac{2v_e}{c} n \sin\frac{\theta}{2}. \qquad (5)$$

Then all the four species have the same shifts and there can only be 3 pairs of Doppler components. The effective elastic wave front always bisects the internal angle between the incident and scattered directions and the scattering process may therefore always be regarded as "specular reflection". Further when $\theta \to 0$ $\Delta\nu \to 0$ and therefore, in the forward scattering the frequency shifts are vanishingly small.

To give an idea of the differences in the Doppler shifts for the four species, the calculated values of the frequency shifts are given below for backward scattering along the normal to the cleavage face of calcite for λ 2537 excitation. They are in cm.$^{-1}$ P_A—3·31, 1·43,1·24; Q_B — 3·06, 1·32, 1·15 ; P_B — 3·19, 1·38, 1·19 ; Q_A — 3·19, 1·38, 1·19. The differences are well within the limits of measurement and some experiments have been made which support these ideas. The full details are, however, reserved for another communication.

The author wishes to thank Prof. R. S. Krishnan and Dr. G. N. Ramachandran for their keen interest in the problem and the National Institute of Sciences for the award of the Junior Research Fellowship.

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1950 NOBEL AWARDS FOR CHEMISTRY AND MEDICINE

THE Nobel Prize for Chemistry has been awarded this year jointly to the German organic chemists, Prof. Otto Diels and Prof. Kurt Alder. They were the co-discoverers in 1929 of the well-known reaction, which has since been called the Diels-Alder Reaction. The reaction consists in the addition of compounds containing a conjugated system of double bonds quantitatively to compounds containing groupings like CH : CH·CO to form cyclic compounds. Both Diels and Alder have continued to develop and apply this technique of "Diene Synthesis" to various problems during the last two decades. These studies have played a large part in the preparation of synthetic rubber. Diels is also the author of a well-known text-book of Organic Chemistry in German, which has since been translated into many other languages.

The Nobel Prize for Medicine has been awarded jointly to Drs. Philip S. Hench and Edward C. Kendall, of the Mayo Clinic, Rochester, Minnesota, and to Prof. Tadeus Reichstein, of the University of Basle, Switzerland. This recognizes not only the recent outstanding work (first published last year) on the treatment of rheumatoid arthritis with cortisone and A.C.T.H., but Dr. Kendall's earlier important contributions to biochemistry—the first crystalline preparation of thyroxine in 1914, the first synthesis of glutathione in 1929, and numerous chemical studies of the adrenal cortical hormones—and also Dr. Reichstein's fundamental chemical work on the steroids of the cortex which led him to the original discovery of cortisone, in 1937, and of desoxycoricosterone acetate, as well as his successful synthesis of vitamin C in 1933.

RESEARCH IN RELATION TO THE DEVELOPMENT OF THE PHARMACEUTICAL INDUSTRY

IN the course of his inspiring address to the Indian Pharmaceutical Congress Association held at Calcutta during the last week of December 1950, Sir J. C. Ghosh, Director, Indian Institute of Technology, Kharagpur, recalled the great and pioneering work of Acharya Ray, which helped to forge the closest links between chemistry and pharmacy. He said: "All knowledge is one, specially when that knowledge is dedicated to the common task of improving the health of our people and curing the diseases so frightfully prevalent in this country. May the members of this Congress and all those who are gathered here today, dedicate themselves, and not their knowledge alone to the great task!

"We are living at the dawn of a new era. We must strive hard that this dawn does not fade into darkness again, but break into a bright day of better life. Public health is one of the several sectors of national life—perhaps the most important one—in which this battle has to be fought and won" through a planned and concerted mobilisation of pharmacists, medical men, chemists and their sympathisers in other allied professions.

The Rank and File Make an Organisation

Sir J. C. Ghosh went on: "Contrary to the view held in some quarters in this country, I believe that a few men at the top cannot make a great organisation. An association ultimately becomes what its rank and file make of it. You have therefore to be very alert about the quality of men who enter your profession. Their professional ethics must be high. Wherever you notice that temptations of commercialism overwhelm character and suppress the ideals of service, you have to take stern action. Things being what they are in India today, disciplinary action against members who bring discredit to your profession, should be, for you, a subject of serious consideration. Your rank and file should not only have high professional ethics but also high professional competence."

Knowledge is Power

Proceeding with his address he declared, "Knowledge is power, but to be really effective, this knowledge must be up-to-date. However keen the struggle for existence may be, a member of your association will not be true to his profession if he does not keep his knowledge up-to-date. We have been for long accustomed in this country to medication in the form of compounded dosage of drugs. But in the progressive parts of the world, this kind of medication is rapidly falling into disuse. Glandular products, antibiotics and, above all, single chemicals, either obtained synthetically or derived from plant and animal sources, are being used more and more as specific remedies for diseases. In Calcutta, one cannot recall too often the great work which Dr. Brahmachari did in stamping out *kalazar* by the use of Urea-Stibamine as a specific remedy. Politicians may disagree, but this single discovery is doing more to bring prosperity to Assam than all other schemes of national reconstruction in that region put together. And mind you, this discovery was made in a laboratory and a hospital which could, by no stretch of imagination, offer reasonable facilities for research. Where there is will to conquer, adverse circumstances may slow down progress, but cannot be an effective deterrent.

Cross-Fertilisation of Ideas

Fortunately we have in India today many public institutions far better equipped for researches on drugs than Brahmachari's laboratory in the Old Campbell Medical School. You know, far better than I do, the beneficent activities in which they are engaged. I have always felt and pleaded that drug enquiry should not remain the exclusive responsibility of medical institutions. Here is a border region, where cross-fertilisation of ideas from the sciences of physiology, bacteriology, bio-chemistry and organic chemistry may bear wonderful fruit. Accordingly, in the Indian Institute of Science, one such unit of drug enquiry was started based on the collaboration of workers in the allied sciences. Similar centres are also being developed elsewhere. I hope that these centres will in due course, fulfil the expectations of their sponsors.

The Penicillin Project

It is fortunate that the National Government is keenly alive to their responsibilities for developing this branch of research. You will be interested to learn that Dr. Jivraj Mehta and General Sokhey have recently been able to pilot through the Ministries of the Governments of Bombay and India a scheme for the commercial manufacture of penicillin and allied drugs. The projects will be executed with the technical collaboration of a firm of Swedish Consultants at an approximate cost of about 4 crores of rupees, which will be shared equally by the two Governments concerned. One of the commendable features of the project is the emphasis that is laid on researches on anti-

biotics and the continuous quest for newer and better drugs in this field.

Self-Sufficiency in Drugs

The Council of Scientific and Industrial Research, under the leadership of Dr. Bhatnagar have set up a Central Drug Research Institute at Lucknow. As is usual with Dr. Bhatnagar, this institute is being planned to be one of the best of its kind.

He emphasised the urgent need of a rapid expansion of the industry, specially in the field of synthetic drugs and anitibiotics, so that *we may attain self-sufficiency in a decade.*

This object can be achieved, if the industry receives (*a*) the patronage of the consuming public, (*b*) generous support from the State and (*c*) if the management have the vision to recognise that research is in this, more than in any other field, the elixir of life of industry.

Research not a Luxury but an Essential Requisite for Progress

There is a school of thought in this country whose advocates do not believe that scientific and technical research is necessary for the industrial development of the country. They consider that all that is needed is to decide on general grounds if the country has the potential resources in power, raw material and transport, which will justify the establishment of any particular industry, and then import into the country the necessary machinery and experts for the purpose. Wherever necessary they would enter into an agreement for technical assistance with a foreign concern and secure the right to use their patents and access to their 'know-how' on payment of big royalties and fabulous fees. They are in favour of providing such technical education in the country which will enable the industry to be run by indigenous talent after a period of probation under foreign experts. They would strongly support technical and vocational education, but stop at research as being more in the nature of a luxury. I have often met this attitude in our powerful industrial magnates and entrepreneures in business. To them the history of the dyestuffs industry should be an object lesson. The first synthetic dye was made in England by Perkin, but the industry soon found a congenial home in German soil. In Germany the practical outlook of businessman is, more often than anywhere else, enthused by that faith in scientific research which comes from first-hand knowledge. Thus, twenty long years of painstaking research were necessary at a cost of more than a crore of rupees before Bayer's process for the synthesis of indigo could be commercialised. But once it was done, the fate of the natural indigo of Bihar was sealed and it disappeared from the world's market in another twenty years. The attitude in Great Britain, on the other hand, was one of complacent 'wait and see'; and the result was that in 1914 she had no dyestuffs industry of any importance. As the war progressed it was realised that the British dependence on Germany for dyes was a fatal mistake. Modern war depends for its successful prosecution on an abundant supply of a large variety of chemicals; and a dyestuffs and fine chemicals industry must be considered an integral part of every defence programme. The British Government took immediate and far-reaching steps. Beginning with a direct and large subsidy for the formation of a company, which ultimately was absorbed in the Imperial Chemical Industries, millions of pounds were spent on developmental research in every branch of the industry. Later on, the importation of dyes and even intermediates were prohibited. As a result, Sir Gilbert Morgan in 1939 claimed with justifiable pride that of the five most fundamental discoveries in dyestuffs chemistry since 1921, the world owed three to British talent. The Imperial Chemical Industries are not only producing now their home requirements but have also in addition a considerable export trade. They have also become pioneers in research on insecticides and anti-malarials. Their gammaxene is now contesting the pride of place with D.D.T. as the most effective insecticide. Their paludrine is now considered the most potent of all anti-malarial drugs. This altered attitude in Great Britain is reflected in the Ormsby Gore Report which observes that "no nation can advantageously depend only on the efforts of other nations for the purpose of promotion of knowledge. This is not only because such dependence is an ignoble parasitism, but also because in the field of international relations no less than in natioal life, the power that comes from kowledge comes from its early and rapid use and from close contact with men who have created this knowledge. The conviction has now become universal that the nation, which will enjoy the benefits of science in the day-to-day progress of its industries and agriculture, is the nation which habitually applied to them scientific method and scientific knowledge; and it is that nation which will be able to seize the advantage of the more spectacular achievements of science in its economic life."

WEALTH OF INDIA, VOL. II—A PREVIEW

A PART of the second volume of the *Wealth of India* pertaining to Raw Materials—a series publication, sponsored by the C.S.I.R., is scheduled to appear in a couple of weeks. The first volume of this encyclopædic work on the natural resources and the industrial products of India was issued in December 1948. In his foreword to the series, Prime Minister Jawaharlal Nehru said:

> "I have found this dictionary fascinating and it has opened out vistas of thought to me. I have no doubt that this book, produced by many scholars and experts and after much labour, will be of great value to the builders of new India."

In the course of their appreciative and critical reviews of the series, some of the international science Journals, wrote that, "This monumental work assembled by a number of Indian scholars supersedes and immeasurably improves on the classic works of George Watt" and added that, "every student of plant utilization will be induced to wish that comparable reference works on economic plants of other countries were also available. It is unquestionably one of the greatest assemblages of information on economically important plants." (Economic Botany).

Nature said, "A high standard is maintained throughout, and the articles contain adequate literature references. The book is fully illustrated with many coloured plates and it is printed on excellent paper. It reflects the highest credit on the Chief Editor and his staff."

Science Progress wrote, "that the authors and editors have accomplished their task with considerable success. The great majority of the articles are models of concise and authoritative statement, references to original literature have been abundantly provided, and there is a welcome absence of excessive detail."

The second volume just released for distribution comprises articles beginning with the letter C and deals *inter alia* with about 230 genera of economic plants with their numerous species, eight important minerals, and seven animal products. The following classified statement gives the subjects on which information—production, processing, utilisation and trade—has been assembled and presented.

Beverages: Tea, Coffee.

Fibre: Jute, Cannabis, Sann Hemp, Silk Cotton Tree, Caryota, Calotropis.

Fodder: Cenchrus, Cyperus, Cynodon.

Fruits: Papaya, Citrus, Cucumis.

Gums and Resins: Guar Gum, Indian Bdellium, Katira Gum, Black Dammar.

Medicinal Plants: Senna, Chenopodium, Pyrethrum, Ergot, Bhang, Cinchona.

Oil Seeds: Coconut, Carthamus-safflower.

Perfumes and Essential Oils: Camphor, Civet, Lemongrass, Palmarosa.

Pulses: Bengal gram, Red gram.

Root Crops: Chicory, Turmeric, Colocasia.

Spices: Chillies, Coriander, Cumin, Tejpat.

Tans: Avaram, Dividivi.

Vegetables: Canavalia, Cucumis, Cucurbita.

Wood and Timbers: Deodar, Casuarina, Cane, Chikrassy.

Minerals: Coals, Clays, Copper ores.

Animal Products: Cochineal, Camels, Crocodile.

The volume covers 480 pages (8¼" × 11") and is printed on art paper. It is profusely illustrated with line drawings, half-tones, graphs and maps; mono- and multi-coloured plates are included. The volume is beautifully bound in deep blue rexine.

CENTENARY OF THE GEOLOGICAL SURVEY OF INDIA—1851-1951

THE Geological Survey of India, one of the oldest official organisations of its kind in the world, is due to celebrate in January 1951 the first hundred years of its existence as an organised department.

The main celebrations will be held in Calcutta from January 10th to 14th, 1951. These will include an exhibition illustrating the history of the Department and the progress of geological discovery in India, and a Commemoration Ceremony on January 13th. This will be followed by a tour to places of geological and mining interest in Northern India, concluding at Delhi on January 28th.

To commemorate the occasion, the Government of India have extended a warm invitation to other countries, and to their official Geological Surveys and learned Societies, to participate in the Centenary Celebrations.

The Geological Survey of India, in friendly collaboration with the sister organisations of the world, will, it is hoped, continue to play a vital role in advancing the boundaries of geological knowledge, and at the same time orientate its activities to the pressing material needs of a nation just reborn.

LETTERS TO THE EDITOR

A NOTE ON JOSHI EFFECT

Rais-Ahmed and Gill[2] have offered a new explanation of "Joshi Effect". According to them, (*a*) most of the gas amplification occurs near the anode and the current is mostly carried by the electrons; (*b*) irradiation increases ionisation with a corresponding increase in the positive space-charge near the cathode. The increased positive space-charge decreases the field gradient at the anode with a consequent decrease in the gas amplification. Thus, a current decrease on irradiation is to be expected.

This simple explanation is inconsistent with some of the important experimental results:

1. According to the proposed explanation ordinary D.C. discharge tubes should also show the Joshi effect. But Joshi effect appears to be peculiar to the ozoniser discharges which can only be worked with alternating or unidirectional pulsating voltages.

2. The magnitude of the effect should depend on the volume of the gas ionised. Results of Joshi,[3,4,5,7] Shukla[9] and Deb and Ghosh[1] clearly indicate the surface origin of the phenomenon.

3. The decrease in the field gradient at the anode will clearly depend on the magnitude of the positive space-charge near the cathode. In the case of halogens, the problem is complicated by the fact that the negative component of the current is in a good measure carried by the negative ions instead of the electrons. Hence the anode fall of potential in halogens in some cases is as high as thousand volts. Irradiation in the visible cannot, therefore, appreciably affect the anode fall of potential and therefore the field gradient near the anode. The effect on the new mechanism should, therefore, be least in halogens. Results of Joshi[5] indicate that the effect is maximum in chlorine.

4. Since the decrease in the gas amplification is due to increased positive space-charge density, it is to be expected that the magnitude of the effect should increase with increase in the positive space-charge density (*i.e.*, with increased ionisation) and should therefore be maximum with X-rays. Joshi[6] finds that *ceteris paribus* the effect is less under X-rays than in the visible. Karmalkar[8] in iodine vapours observes a positive effect under X-rays, a negative effect under white light and an effect equal to the algebraic sum of the positive and negative effects when irradiated simultaneously with X-rays and white light.

The results are just the opposite of what is expected from the theory of Gill and Rais-Ahmed.[2] The results however find a simple explanation on Prof. Joshi's theory.[7]

According to Prof. Joshi,[7] (*a*) an adsorbed layer, in dynamical equilibrium with the gas

phase, is formed on the dielectric surface during the discharge; (b) on irradiation photo-electrons are emitted from the adsorbed layer; (c) the photo-electrons are converted into the slow moving negative ions due to the electron affinity of the excited gas molecules. These slow moving negative ions decrease the current as in the space-charge effect.

It is evident that any factor which tends to decrease the magnitude of the negative space-charge will tend to decrease the Joshi-effect. The positive effect under X-rays is due to the intense ionisation due to X-rays. The increased ionisation due to X-rays increases the positive space-charge density. This increased positive space-charge reduces, *in effect*, the negative space-charge formed under light, which according to Prof. Joshi's theory reduces the light effect under simultaneous irradiation with X-rays and white light, as observed.

Grateful thanks are due to Prof. S. S. Joshi of Banaras Hindu University and to Prof. M. F. Soonawala, of Maharaja's College, Jaipur, for their keen interest and kind encouragement.

Physico-Chemical Labs., G. V. Bakore.
Maharaja's College, Jaipur,
August 31, 1950.

1. Deb and Ghosh, *Science and Culture*, 1946-47, **12**, 17-19. 2. Rais-Ahmed and Gill, *Curr. Sci.*, 1950, **19**, 207-08. 3. Joshi, *Ibid.*, 1939, **8**, 548. 4. —, *Presidential Address, Chemical Section, Indian Science Congress*, 1943. 5. —, *B.H.U. Journal*, 1943, **8**, 101-03. 6. —, *Curr. Sci.*, 1944, **13**, 278. 7. —, *Ibid*, 1947, **16** 19-21. 8. Karmalkar, *M.Sc. Thesis*, 1950, Agra Univ. 9. Shukla, *Jour. of Phy. and Colloidal Chem., U.S.A.*, 1949, **53**, 1239-54.

A NOTE ON JOSHI EFFECT

In a recent note entitled as above, Rais-Ahmed and Gill[1] cite the following equations for the current:

(1) $J_e = J_0 e^{\alpha d}$; (2) $J_g = \rho_e E g_e$; and (3) $J_i = \rho_i E g_i$.

These equations are inapplicable except in a uniform field. For instance, the amplification coefficient α being *position dependent* in a non-uniform field, $e^{\int_0^d \alpha dx}$ should have been used in place of $e^{\alpha d}$ in equation (1).[2] Further, most of the ionization needed for maintaining a given current being known to be completed within a critical distance d_c this last and not the full interelectrode distance d is relevant to current stability as implied in equation (1). Another circumstance overlooked by the authors[1] is the disparity in the field intensities E_c and E_a at the two electrodes, E_c at the cathode being greater than E_a at the anode, except in the positive corona where the reverse holds.[3] This contradicts the authors' assumption of E being identical at the two electrodes, in equations (2) and (3).

Furthermore, the authors designate the excited tube as a 'diode'; this is ambiguous. Both positive and negative Joshi effects have been observed over a pressure range of 0·002 mm. Hg[4], which is not dissimilar to that in a soft diode, to about 800 mm. Hg,[5] and in various types of discharge tubes, *e.g.*, the full ozonizer, (GM counter-like) semi-ozonizer,[6] Crookes and Geissler forms of discharge tubes fitted with internal metallic electrodes,[7] and those excited by external sleeves.[8] None of these can be described usefully as a diode except perhaps in a distant sense and over a restricted range of operative conditions. The authors' current equations are further defective in that they do not include secondary amplification term distinct from α (Townsend), essential for the stability of the discharge.[9] Lastly, it may be pointed out that both photo-ionization[10] and a rise of the potential gradient in the cathode region,[11] as postulated by the authors, should cause a *current increase*, radiation that can ionize a gas being known to be one of the possible agents of secondary amplification.[10]

The remark, "obviously, if by intense illumination ionization is further increased", envisages Joshi effect as a volume effect. Experimental data from these Laboratories in respect of numerous media and covering a wide range of exciting conditions show that the Joshi effect is fundamentally of surface origin, or more precisely, "solid (electrode)—gas interface".[12] In the end, it may be noted that the work of Fuchs[13] and Salzwedel[14] cited by the authors and specifically mentioned by me during discussion referred to by them, is limited to ultra-violet irradiation of the metal cathode, which discriminates their finding from the more general Joshi effect.

The Chemical Laboratories, H. J. Arnikar.
Banaras Hindu University,
September 22, 1950.

1. Rais-Ahmed and Gill, *Curr. Sci.*, 1950, **19**, 206. 2. Loeb, *Fundamental Processes in Electrical Discharge*, 1939, pp. 387-91; 488-90; 511-13; 568. Townsend, *Electrons in Gases*, 1947, p. 153. 3. Loeb, *l.c.*, pp. 564-66; 485-86. 4. Baijnath, *Nature*, 1944, **164**, 69. 5. Joshi and Deo, *Ibid.*, 1944, **153**, 434. 6. Joshi, *Presidential Address to the Chemistry Section, Ind. Sci. Cong.*, 1943. 7 — (unpublished results). 8. Jatar, *Proc. Ind. Sci. Cong.*, 1949, Part 3, *Phys. Sect.*, Abs. Nos. 20, 21.

9. Loeb, *l. c.*, pp. 423-25; 488-94; 511-13; 581-85. 10. —, *l. c.*, p. 403. 11. Emelius, *Conduction of Electricity through Gases*, 1929, p. 33. 12. Joshi, *Curr. Sci.*, 1945, **14**, 35; 1947, **16**, 19. 13. Fuchs, *Zeit. fur. Phys.*, 1936, **103**, 709. 14. Salzewedel, *Ann. der Phys.*, 1927, **82**, 305.

COMMENT ON NOTES BY G. V. BAKORE AND H. J. ARNIKAR

BAKORE AND ARNIKAR in their notes on 'Joshi Effect' refer to a previous note[1] by Prof. Gill and myself.

Firstly, in the earlier note no new explanation for 'Joshi Effect' was advanced. It was only pointed out that a consideration of gas amplification commonly found in standard textbooks might help to explain the experimental results. W. G. Dow[2] writing about change of current in gas phototubes clearly says that "under some conditions an increase in illumination may reduce the total tube current". Secondly, the quantity α which was used in the previous note does not pertain to a volume effect. It simply depends on gas concentration, on the exciting and ionizing potentials and their probabilities for the gas used, and on the ratio of field strength to gas concentration. The existence of a highly ionized layer of gas next to the dielectric cathode was not ruled out. In fact, some of the experiments on special Geiger tubes in this laboratory have led us to consider the accumulation of ions on the surface of the glass electrode.

The more exact equations referred to by Arnikar do not in any way alter the conclusions which may be derived from the simplified equations. Of course, E_e is greater than E_d but this does not compensate for the fact that the mobility of electrons g_e is very much greater than the mobility of ions g_i. Bakore's example of chlorine does not indicate if the pressure regions, where such great anode falls are encountered, are exactly those where the negative effect is greatest.

The effect still appears analogous to similar phenomena in other types of discharges, and perhaps a conventional explanation can do for this too.

Physics Department, RAIS-AHMED.
Aligarh University,
October 12, 1950.

1. Rais-Ahmed and P. S. Gill, "A Note on Joshi Effect," *Curr. Sci.*, July 1950. **19**, 206-07. 2. Dow, "Fundamentals of Engineering Electronics," John Wiley & Sons, New York, 1944, 412.

TWO HITHERTO UNREPORTED PLANT FOSSILS FROM THE RAJMAHAL HILLS, BIHAR

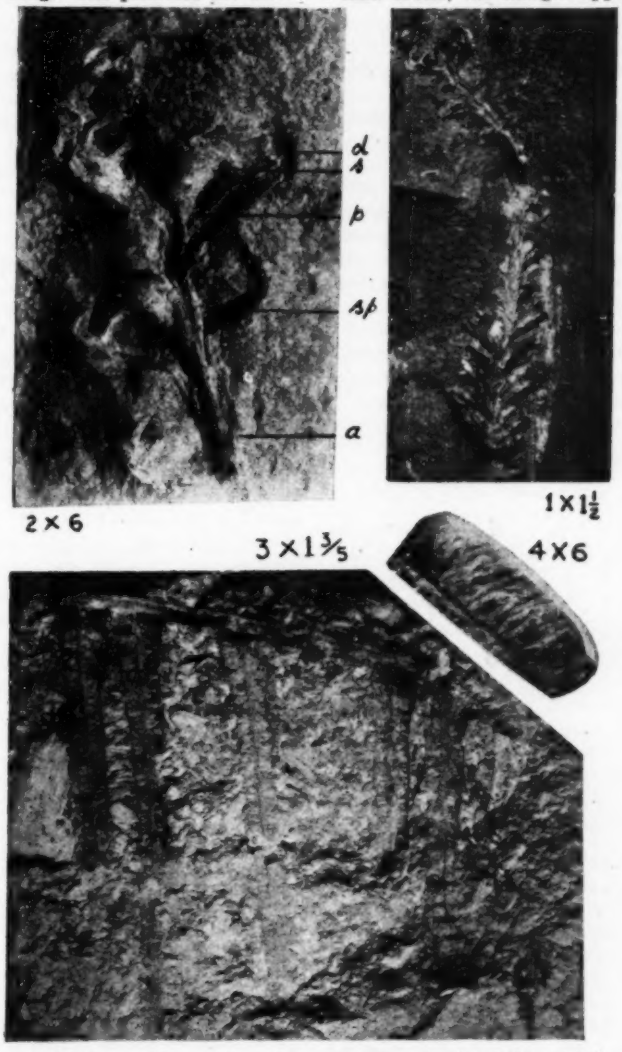
A COLLECTION of plant fossils made from several localities in the Rajmahal Hills in Bihar in 1946 and which is being worked out at present, has shown a number of interesting impressions. Two of them hitherto not reported from the Rajmahal Hills, are briefly described in the present preliminary note.

Stachyotaxus sp. (Photos 1-2).—This impression of a fertile specimen is borne on the hard rock characteristic of the well known locality *Onthea*. The specimen is not very satisfactorily exposed owing to the irregular fracture of the rock under the hammer. Still the shoot and its connection with the strobilus is fairly clear although the exact connection is missing (Photo 1). The entire specimen measures about 5½ cm. long by a centimetre broad. The leaves are 5 mm. long, 1 mm. broad, show a narrow twisted base and generally conform to the type known as *Elatocladus conferta*. The apex of the leaves and the epidermal features could not be made out. The axis of the shoot extends into a strobilus (Photo 2); 2 cm. long by ·7 cm. broad, bearing distantly and perhaps oppositely arranged sporophylls. Each sporophyll arises almost at right angles to the axis and measures about 7-8 mm. in length. The distal part of each sporophyll is bent at right angles and bears two sockets which evidently bore the two seeds. They measure about 4 mm. long by 1·5 mm. broad, were probably drupaceous in nature and their micropyles faced the axis of the stobilus. The seeds are not fully preserved but the compressed seed coat can be seen clearly. The exact shape of the seed and its mode of attachment to the sporophyll is not very clear.

Nathorst (1908) who instituted the genus *Stachyotaxus* described two species—*St. elegans* and *St. septentrionalis* from Sweden. My specimen resembles to a certain extent the latter species. Halle (1913, p. 83) pointed out the resemblance between *Stachyotaxus* and some twigs of *Elatocladus* from Grahamland. My specimen resembles rather very closely the megastrobilus known as *Beaniopsis rajmahalensis* Ganju (1947, p. 95) also described from the Rajmahal Hills. The foliage of this is not known. The longer axes of the two seeds on each sporophyll diverge from each other, but their principal planes are in continuation with each other. These seed characters if they are the normal feature of the plant and not due to any accident in preservation, constitute the

main difference between *B. rajmahalensis* and my specimen.

Laccopteris (*Phlebopteris*) sp.—This interesting fragment (Photo 3) is part of a pinnate fern frond and is 4 cm. long. The pinnules are seen on only one side and only 5 are preserved and the bases of three more can be made out. The longest of the pinnules measures about 4·5 cm. in length. The pinnule arises almost at right angles and is attached to the longitudinally striated rachis by its entire width. The pinnule measures about ½ cm. at the base and gradually tapers down to an acute tip about 1 mm. broad; the margin appears to be slightly revolute. The conspicuous midrib is grooved on the upper side and striated on the lower side. The venation is of the *Laccopteris* type with the basal meshes which however are not



1. *Stachyotaxus* sp. part of shoot with strobilus; the exact connection is missing, × 1½. 2. Strobilus magnified—*sp*, sporophyll; *p*, proximal, *d*, distal upturned, part, *s*, seed *a*, axis, × 6. 3. *Laccopteris (Phlebopteris)* sp. part of incomplete pinna showing some pinnules on one side only. × 1 3/5. 4. Part of pinnule showing the soral bulges on the upper surface × 6.

very many. Most of the fertile leaves have lost the sporangia, probably before fossilization, but their position can be made out by the bulges on the upper surface in the region of the sorus (Photo 4). The sori occur in two rows on both sides of the midrib, not more than 1 mm. from each other and generally consist of six round sporangia grouped together. My specimen shows some points of resemblances with *L. polypodioides* (Seward, 1910, p. 358), but I would prefer to postpone its specific determination till more satisfactory material is available. The above two well-known Rhaetic plant fossils recorded for the first time from the Rajmahal Hills serve to link the Grahamland flora and the Greenland flora on the one side with the Rajmahal flora on the other. The affinities between these floras have already been noted by Halle, Sahni and others.

I am greatly indebted to Prof. T. M. Harris, of Reading University, who examined my specimens and gave some helpful suggestions.

Dept. of Botany, A. R. Rao.
Lucknow University,
September, 1950.

1. Nathorst, ' Uber *Palissya, Stachyotaxus* und *Palaeotaxus*," *Palaeobot.*, 1908, *Bd.* **43**, No. 8; *Kungl Svensk-vetenskapsakad. Hand.* **43**, 8. Halle, " The mesozoic flora of Grahamland," *Wiss. Ergeb. Schwed*, 1913, Südpolar, Exped, 1901-03 *Bd.* **3**, Lief 14, p. 1. Ganju, " On *Beaniopsis rajmahalensis* gen et sp. nov., a new type of gymnosperm female fructifications from the Jurassic of Bihar," *Proc. Nat. Acad. Sci.*, 1947, **25**, 95; Seward, *Fossil Plants*, 1910, **2**.

IODINE MONOCHLORIDE AND IODINE TRICHLORIDE AS CHLORINATING AGENTS

Iodine monochloride and iodine trichloride are powerful iodinating agents. G. H. Woolet and W. W. Johnson (*Org. Syn.* 1934, 14, 52-53) obtained 3 : 5-diiodo-salicylic acid by the action of iodine monochloride on salicylic acid in glacial acetic acid. Colbert, Houghton, Schmidt and Abernathy (*J.A.C.S.* 1944, 122-4) prepared 3-iodo and 3 : 5-diodo-4-hydroxy diphenyl in a similar manner. The reagent was used by A. H. Blatt (*Org. Syn.* 1943, 343) for the preparation of 3 : 5-diiodo-salicylic acid.

We attempted iodination of (1) 2-hydroxy 3-naphthoic acid, (2) alizarin and (3) 4,4'-dihydroxy diphenyl by the action of iodine monochloride in glacial acetic acid. The reactions were studied both at room temperature and 100° C. The action of iodine trichloride has also been studied on (2) and (3) at 100° C.

1 g. of each of the compounds was dissolved in 20-25 c.c. of hot glacial acetic acid and the solution after cooling to room temperature, was treated with 15-20 c.c. of ICl solution for about an hour and the reaction mixture was set aside for 4-12 hours (depending upon the compound used) and then worked up for the product. The crystalline derivatives gave negative tests for iodine and positive for chlorine. They were then identified by mixed melting point with authentic samples of the chloro derivatives prepared and identified earlier by standard method.

The reaction with all these compounds at both the temperatures was quite rapid, but instead of iodo derivative being formed as expected, the products obtained were identified as the chloro derivatives. Not even traces of iodo derivatives were isolated. 2-hydroxy-3-naphthoic acid gave 1-chloro, alizarin, the 3-chloro and 4,4'-dihydroxy diphenyl, the 3 : 5 : 3' : 5' tetrachloro derivatives. The yields of the chloro derivatives were excellent:—(1) gave 63 per cent. and 74 per cent., (2) gave 68 per cent. and 75 per cent. and (3) gave 67 per cent. and 69 per cent. at room and at water-bath temperatures respectively. With iodine trichloride the yield of the tetrachloro derivatives was still higher, i.e., 71 per cent. while that of 3-chloro alizarin remained 75 per cent. only.

It seems that the probable explanation is as follows: Iodinemonochloride in glacial acetic acid exists in two ionic forms—$I^+ + Cl^-$ in dynamic equilibrium with $I^- + Cl^+$. Since both chlorination and iodination are cationoid reactions and since both Cl^+ and I^+ exist at any time in the reaction mixture the chances of formation of both the derivatives chloro as well as iodo are equal. However, the factors like stability of the final product determine the course of the reaction. Since in the case of these three compounds (1), (2) and (3) C-Cl bond is relatively more stable than the C-I bond, it is probable chlorination takes precedence over iodination. Further, more systematic work is being undertaken in our laboratory to establish the conditions under which ICl and ICl_3 would function as chlorinating agents.

A. M. Gandhir.
A. L. N. Fonseca.
St. Xavier's College, F. Rebello.
Bombay-1, A. N. Kothare.
October 24, 1950. V. V. Nadkarny.

SYNTHESIS OF 2:3-CYCLOPENTENONAPHTHALENE AND ITS 7-METHYL DERIVATIVE

2 : 3-CYCLOPENTENONAPHTHALENE (5 : 6-Benzohydrindene) and 7-methyl-2 : 3-cyclopentenonaphthalene, have been synthesised as follows: (1) Δ′-cyclopentene-1 : 2-dicarboxylic acid anhydride condensed with benzene in presence of anhydrous aluminium chloride with the formation of Δ′-cyclopentene-1-benzoyl-2-carboxylic acid (m.p. 181-182°, semicarbazone m.p. 240°). This ketoacid on reduction by the Clemmensen method gave Δ′-cyclopentene-1-benzyl-2-carboxylic acid (b.p. 170-173°/4 mm., anilide m.p. 130°-131°). This was cyclised by heating with fused zinc chloride to 1-keto-2 : 3-cyclopenteno-1 : 4-dihydronaphthalene (b.p. 145–150°/5 mm.; semicarbazone m.p. 177°-178°) which on reduction by the Clemmensen method gave 2 : 3-cyclopenteno-1 : 4-dihydronaphthalene (b.p. 105-107°/5 mm.). The latter on dehydrogenation with Pt-C catalyst in the liquid phase gave 2 : 3-cyclopentenonaphthalene or 5 : 6-benzohydrindene (m.p. 95°; picrate m.p. 120°-121°; styphnate m.p. 153°) identical with a sample prepared previously by a different route.[1]

(2) In a similar manner, Δ′-cyclopentene-1-(p-toluyl)-2-carboxylic acid (m.p. 200°; semicarbazone m.p. 230°) was obtained from toluene and Δ′-cyclopentene-1 : 2 dicarboxylic acid anhydride. This on Clemmensen reduction gave Δ′-cyclopentene-1-(4′-methylbenzyl) 2–carboxylic acid (b.p. 175-176°/3 mm.; anilide m.p. 143°) which on cyclisation with zinc chloride gave 2 : 3-cyclopenteno-1-keto-1 : 4 dihydro–7–methyl naphthalene (m.p. 55°; semicarbazone m.p. 208°). The keto compound on Clemmensen reduction gave 2 : 3-cyclopenteno-1-4-dihydro-7–methylnaphthalene (m. p. 53°), which on dehydrogenation with Pt-C catalyst gave 2 : 3-cyclopenteno-7-methylnaphthalene (m.p. 104°, picrate m.p. 107°-108°) identical with 6 : 7-cyclopenteno-2-methyl naphthalene which was obtained by a different route.[1] The experimental details will be published in due course. This method is being actively pursued for the synthesis of similar polycyclic hydrocarbons.

Chemical Laboratory, S. C. SENGUPTA.
Krishnagar College, N. N. SAHA.
Krishnagar, Nadia,
West Bengal,
October 3, 1950.

1. *J. Ind. Chem. Soc.*, 1939, **92**.

THE CHLORINE-SULPHITE TEST FOR LIGNIN

THE pink colour that a ligno-cellulose gives with chlorine and sodium sulphite solution is generally employed as a test for residual lignin during the estimation of cellulose by Cross and Bevan or Norman and Jenkins method.[1] Both native and isolated lignin respond to this colour reaction. Lignin is believed to form chlorolignin which dissolves in the sulphite solution with a pink colour. But it has recently been observed in these laboratories that a boiling-water extract of jute and some other bast fibres gives this test. The deep brown solid obtained on evaporating the aqueous extract of jute, is acidic in nature, reduces Fehling's solution, has about 13 per cent. methoxyl, dissolves mostly in 72 per cent. sulphuric acid, as also in acidified sodium chlorite solution at about 100°, and yields galactose on hydrolysis with dilute sulphuric acid.

Since it is difficult to imagine the presence of lignin in the aqueous extract of a ligno-cellulose, the development of a pink colour with chlorine and sodium sulphite may not be a sure test for lignin. The water-soluble fraction of jute fibre presumably contains a precursor of lignin, or some compound having a common group, responsible for the colour.

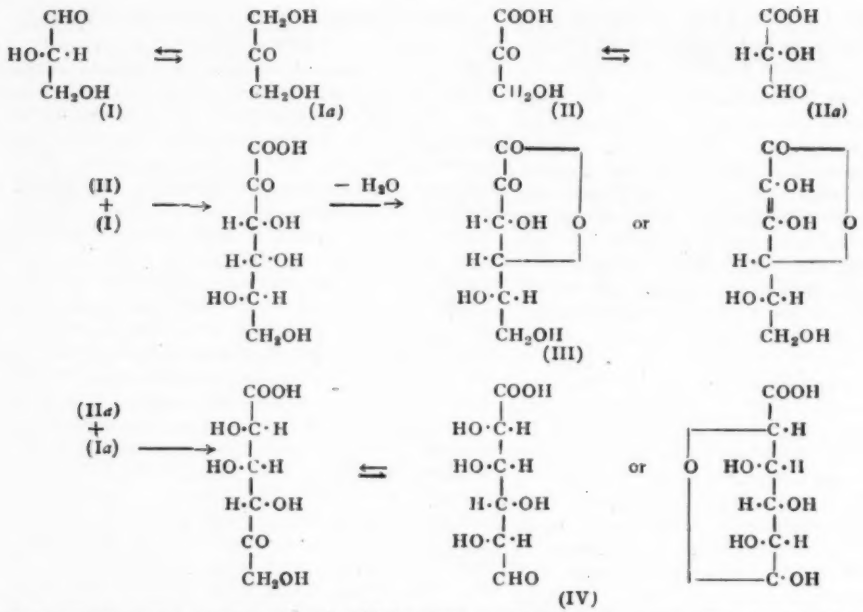
Another interesting fact is that this pink colour is given by the hot 5 per cent. sulphuric acid extract (in Norman and Jenkins method for the estimation of lignin[2]) as well as the 3 per cent. boiling sulphuric acid extract of lignin (in Mahood and Cable's method[3]), indicating apparently some loss of lignin in either case.

Tech. Res. Labs., P. B. SARKAR.
Indian Central Jute Committee,
Regent Park, Tollygunge,
Calcutta-33,
October 21, 1950.

1. Doree, *The Methods of Cellulose Chemistry*, 1947, pp. 352–8. 2. Norman and Jenkins, *Biochem J.*, 1934, **28**, 2147, 2160. 3. Mahood and Cable, *Ind. Eng. Chem.*, 1922, **14**, 933.

THE BIOGENESIS OF ASCORBIC ACID

OF the work reported so far on the possible mechanism of synthesis of ascorbic acid *in vivo* and its immediate precursors, that of C. G. King and collaborators[1–4] appears to give us a significant clue. As a result of their very systematic work carried out in the rat, they arrive at *inter alia* the following conclusions: (1) the ingestion



of "a great many compounds of widely varying molecular constituents" (such as the monocyclic and bicyclic terpene ketones, aliphatic alcohols and ketones, barbiturates, aminopyrin, antipyrin, etc.) cause an increased rate of synthesis and excretion in the urine of ascorbic acid which was identified beyond doubt; (2) "it is improbable that the substances served as direct precursors of ascorbic acid", but they cause "a stimulation of the synthesis of ascorbic acid from the intermediate metabolites";[2] (3) the compounds that stimulate this synthesis are detoxified as the glucuronides and "there appears to be a striking correlation between the metabolism of *d*-glucuronic acid and *l*-ascorbic acid";[3] (4) the ascorbic acid synthesised is of endogenous origin, formed from the tissue metabolites in the same way as *d*-glucuronic acid, and (5) in the study of the synthesis of ascorbic acid by the rat tissue *in vitro*, the best results were obtained with a mixture of glyceraldehyde, pyruvate and hexose diphosphate (glucose, mannose, sorbose and 1-2-ketogulonic acid being ineffective).[4]

The above appear to us to indicate clearly that the formation of *d*-glucuronic acid and ascorbic acid is simultaneous and that they arise out of the same precursors by reaction in two different ways which explain satisfactorily why the compounds that get detoxicated as the glucuronides cause the increased synthesis of ascorbic acid also. We suggest that they are formed from two three carbon units by aldol condensation similar to the formation of fructose and sorbose from two molecules of glyceraldehyde,[5] the two three carbon units (precursors) in this case being glyceraldehyde (I) and hydroxypyruvic acid (II), their tautomeric forms (I*a*, II*a* respectively), or their biological equivalents. The reactions can proceed as shown below in two directions yielding in one case ascorbic acid (III) and in the other glucuronic acid (IV).

Glyceraldehyde can arise from the sugars while hydroxypyruvic acid by, (1) oxidation of pyruvic acid or dihydroxyacetone, (2) transamination of serine, or (3) decarboxylation of dihydroxymaleic acid.

Dept. of Chemotherapy, K. GANAPATHI.
Haffkine Institute,
Bombay,
August 4, 1950.

1. Musulin, Tully, Longenecker and King, *J. Biol. Chem.*, 1939, **129**, 437. 2. Longenecker, Musulin, Tully and King, *Ibid.*, 1939, **129**, 445. 3. —, Fricke and King, *Ibid.*, 1940, **135**, 497. 4. Smythe and King, *Ibid.*, **1942**, **142**, 529. 5. Fischer and Baer, *Helv. Chim. Acta.*, 1936, **19**, 519 ; Schmit, E., *Ber.*, 1933, **66**, 931.

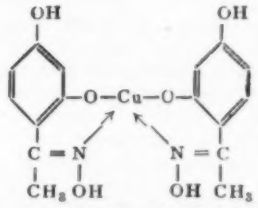
RESACETOPHENONE-OXIME AS AN ANALYTICAL REAGENT FOR THE QUANTITATIVE SEPARATION OF COPPER AND CADMIUM

THE aromatic ortho-hydroxy aldoximes and ketoximes yield bright yellow to greenish yellow copper salts, insoluble in dilute acetic acid. Ephraim[1] studied several compounds of this series and found that their specificity for copper appeared only in acetic acid solution. This author and Astin and Riley[2] employed salicylaldoxime for the detection and determination of copper. It is now widely employed. It is, however, difficult to obtain this reagent in a crystalline form as it has a low melting point, is expensive, and as pointed out by Howe and Mellon,[3] dilute aqueous alcoholic solutions are not quite stable.

Among the oximes examined by Ephraim, resacetophenone-oxime possesses several advantages over salicylaldoxime but it has not been examined previously, as an analytical reagent for copper, in detail. The parent ketone and the oxime (colourless crystals, m.p. 198-200° C.) can be easily prepared in very good yield and the reagent is less expensive. This reagent is readily soluble in alcohol and is not precipitated by large dilution with water. Aqueous alcoholic solutions are quite stable for long periods. Copper gives a bulky brownish yellow precipitate in acetic acid solution but cadmium is not precipitated either from acetic acid or ammoniacal solution. Ferrous iron gives a purplish colour in acetic acid solution and ferric iron a dark red colour in presence of hydrochloric acid. Neelakantam and Sitaraman[4] employed the latter reaction for the colorimetric determination of iron. None of the other common metals gives any precipitate or colour.

The copper complex when precipitated in the cold from acetic acid solution, using an alcoholic solution of the reagent is bulky and light. In the hot coagulation occurs but the precipitate does not settle down.

The following procedure gives the best results:—The copper solution is neutralised with sodium hydroxide and acetic acid (10 c.c.; 2N) added. The solution is diluted to 200 c.c. and heated to boiling. An excess of 1 per cent. alcoholic solution of the reagent is added slowly from a separating funnel with constant stirring. Finally the solution is heated gradually to boiling with occasional stirring. The precipitate is filtered hot through a sintered glass crucible (Schott and Gen, No. 4) and washed with hot water containing acetic acid until the wash liquid gives no colour with ferric chloride. The precipitate is dried to constant weight at 120° C. Drying is complete in 2-3 hours. The results for copper are calculated on the basis of the following structure for the anhydrous complex:



[Molecular formula : $(C_8H_8NO_2)_2$ Cu ; contains 16·06% copper]

These values compare quite well with those obtained by the iodometric and salicylaldoxime methods (*Cf.* Table I).

TABLE I

No.	Copper (mg.)		
	Resacetophenone oxime	Iodometric method	Salicylaldoxime
1	11·8	11·77	11·75
2	11·79	,,	11·79
3	29·45	29·42	..
4	29·47	,,	..
5	29·49	,,	..

Separation of copper and cadmium carried out by the above method gives good results as shown in Table II.

TABLE II

No.	Copper taken (mg.)	Cadmium added (mg)	Copper found (mg.)	Error %
1	29·42	25·0	29·47	+0·17
2	,,	30·0	29·48	+0·20
3	,,	40·0	29·49	+0·24

It is clearly seen that resacetophenone-oxime is quite a satisfactory reagent for the determination of copper and its separation from cadmium. The copper complex contains 16·06 per cent. metal while the corresponding salicylaldoxime complex contains 18·95 per cent. Resacetophenone-oxime is, therefore, recom-

mended as a suitable substitute for the expensive salicylaldoxime.

Chemical Laboratories, N. APPALA RAJU.
Andhra University, K. NEELAKANTAM.
Waltair,
October 26, 1950.

1. Ephraim. *Berichte.*, 1930; **63B**, 1928; *Ibid.*, 1931, **64B**, 1210. 2. Astin and Riley, *J. Chem. Soc.*, 1933, 314. 3. Howe, and Mellon *Ind. Eng. Chem. Anal. Ed.*, 1940, 448. 4. Neelakantam and Sitaraman, *Curr. Sci.*, 1945, **14**, 320.

EFFECTIVE NUMBER OF GENES

THE effective number of genes responsible for the inheritance of a quantitative character have been estimated on the assumption that the effect of each effective gene is equal in magnitude. Making use of a much weaker assumption of symmetry of the distribution of their dominance effect (h_a), we get the required number of genes as

$$k = \frac{3}{2}\,\frac{BH}{G}\left(1 - \left[1 \pm \frac{8BG}{9H^2}\right]^{\frac{1}{2}}\right),$$

where k is the required number; B denotes total dominance (S $[h_a]$); H denotes the unfixable variance (S $[h_a^2]$); and G denotes (S $[h_a^3]$).

By this formula we can only estimate the number of genes-governing characters which show dominance, but this makes no assumption regarding the distribution of the magnitude of their effects.

We further get $D - \frac{A}{k}$ as the variance of the magnitude of the effect of the genes. Here D represents fixable variance [S (d_a^2)]; and A the difference of one parent from the mid-parent value $-$ [S (d_a)].

We also get covariance between the effect and the dominance effect of the genes as $\frac{(kF - BD)}{2A}$, where F = S $(d_a^2 h_a)$.

This quantity has a great potentiality of furthering our knowledge regarding the nature of dominance.

Details will be published elsewhere.

356-E, Govt. Quarters, P. N. MATHUR.
Karol Bagh, Delhi-5,
July 25, 1950.

A NEW BACTERIAL LEAF-SPOT AND STEM CANKER OF PIGEON PEA

A NEW bacterial leaf-spot was first noticed on lower leaves of pigeon pea (*Cajanus cajan* Millsp.) at Jalgaon and Anand in September, 1949. Under ideal conditions, the pathogen produces small, (0·5 mm.), round, water-soaked spots on the leaves after an incubation period of 7 days. The spots as they develop become quadrilateral (1 mm.) and are surrounded by a halo on the upper surface of leaves. Spots which are light-brown initially become dark-brown later and are raised on the upper surface as a result of drying of bacterial exudation. The spots when coalescent form large lesions (2 mm.). In severe cases of infection, spots are found all over the leaf; the infection which extends along the main and lateral veins of the leaf, leaf-edges and the leaf-petioles results in general yellowing and ultimate shedding. On the main stem and side branches, the pathogen produces dark-brown cankers which when numerous and close cause peeling of the bark.

Xanthomonas cajani Sp. nov.

Short rods, gram-negative, capsulated, not acid-fast, motile by a single polar flagellum, stains readily with common dyes and measures 1·3-2·2 × 0·9-1·4 μ. On potato dextrose agar plates, colonies are smooth, shining, with entire margins, pulvinate, colour naphthalene yellow (R), diam. 1·5 cm. after 7 days; on nutrient agar plates, colonies are round, shining, slightly raised, colour baryta yellow (R), dia. 7 mm. after 4 days; milk peptonised; litmus reduced; gelatin liquefied; casein digested; starch hydrolysed; produces acid but no gas in dextrose, lactose and sucrose; salicin not utilised; ammonia and hydrogen sulphide produced; nitrates not reduced; M.R. and V.P. tests negative; sodium chloride tolerant upto 3%; non-lipolytic; Lœffler's solidified blood serum liquefied in 10 days; no growth in synthetic asparagin medium; fair growth in Koser's liquid and solid citrate media; optimum temperature 30° C., thermal death point 51° C.

Pathogenic to *Cajanus cajan* Millsp. Full account will be published elsewhere.

Plant Path. Lab., Y. S. KULKARNI.
Agric. Coll., Poona, M. K. PATEL.
July 30, 1950. S. G. ABHYANKAR.

CHROMOSOME NUMBERS IN GENISTEAE

THE note records the chromosome numbers in *Heylandia latebrosa*, *Rothia trifoliata* and a few species of *Crotalaria* belonging to the tribe Genisteæ (S. F. Papilionateæ).

A study of the chromosome numbers from PMC of *Crotalaria biflora*, *C. bifaria*, *C. hirta* and *C. striata* var. *acutifolia* has revealed $n = 8$. This is in conformity with the previous reports

for the other species.[1,2] The counts from the root-tip cells of *C. biflora*, *C. medicaginea* var. *neglecta*, *C. striata* var. *acutifolia*, *C. anagyroides* and *C. usaramonsis* showed $2n = 16$ thereby confirming the remarkable uniformity of the haploid number 8. The only exception, however, is *C. incana*, which is characterised by $n = 7$ and $2n = 14$.

Heylandia latebrosa and *Rothia trifoliata* resemble *Crotalaria* in having $n = 8$ and $n = 7$ respectively. The tribe Genisteæ, therefore, has basic numbers 7 and 8 and it is a matter of interest to note that the intergeneric relationships in the tribe are based on aneuploidy.

The author is indebted to Prof. A. C. Joshi, D.Sc., for suggesting the problem and for guidance, to Dr. H. A. Sen, Ottawa (Canada), for seeds of *C. incana* and to the National Institute of Sciences of India for the award of a Junior Research Fellowship.

Govt. College, Y. SUNDAR RAO.
Hoshiarpur,
October 5, 1950.

1. Darlington, C. D., and Janaki Ammal, E. K., *Chromosome Atlas of Cultivated Plants*. 1945. 2. Sundar Rao, Y., *Ind. Jour. Genet. Pl. Breed.*, 1943, **3**, 64-66.

THE CHROMOSOME COUNTS OF *CITRUS SUNTARA*

*Citrus suntara** Hort. ex Tanaka, commonly known in the Central Provinces (*Madhya Pradesh*) as *Nagpur santra* is a very important commercial loose-skinned orange of India.[1] The chromosome counts of this cultivated fruit-tree does not appear to have been made so far.[2] It flowers twice a year; during February (*ambé-bahar* flowering) and June (*mrig-bahar* flowering).

A cytological study was, therefore, made in 1942[3] of the different species of *Citrus* with particular reference to *Citrus suntara*. A number of metaphase plates during microsporogenesis was examined, counted and later confirmed. The counts have been found to be consistently $n = 9$ (Figs. 1 and 2). Thus this species too, naturally falls in line with other species of *Citrus* already recorded.[2]

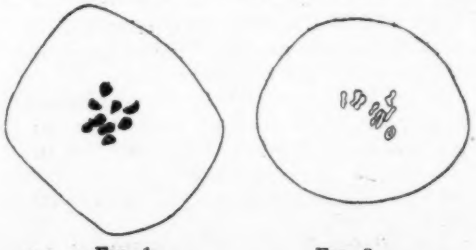


FIG. 1 FIG. 2

FIG. 1. Shows the polar view of the metaphase stage; and FIG. 2. The equatorial view of the same. Magnification × 1350.

Horticul. Res. Institute, T. C. N. SINGH.
Nagpur-Ajni, MISS R. SHAH.
December 25, 1948.

* *Index Kewensis—Supplementum*, 1926-30, **8**, p. 53.

1. The cultivation of this special loose-skinned *Nagpur Orange* is very restricted, confined only to the district of Nagpur. 2. Darlington, C. D., and Janaki Ammal, E. K., *Chromosome Atlas of Cultivated Plant*. (George Allen & Unwin Ltd., London), 1945, pp. 190-91. 3. At the Horticultural Research Institute, Nagpur-Ajni.

ANOTHER STRAIN OF *PHYSALOSPORA TUCUMANENSIS*

THREE types (A, B and C) of *Colletotricum falcatum* Went (*Physalospora tucumanensis*) were described earlier[1]; the light type B was reported to be more virulent than the old dark type A. Type B, because of its association with the epidemic of 1939-40 and 1940-41 and high virulence, was used for susceptibility tests carried out locally and in the co-ordinated tests. The varietal gradations arrived at in subsequent years were based on the tests carried out with type B. Varieties like Co. 508 which were found to be susceptible in the tests were subsequently proved to be such under natural conditions and varieties like Co. 453 and Co. 513 which were found to be comparatively resistant (or less susceptible) continued to be such till the beginning of the 1949-50 season.

Co. 453, which covered a high percentage of cane acreage in North Bihar, was found to be heavily infected with the red rot disease in Champaran and parts of Muzaffarpur and Darbhanga districts. The incidence of the disease on the clump basis varied from stray cases to as high a percentage as 75%. Samples from different localities were collected, cultured and inoculated on standing canes.

A few new types of *Physalospora tucumanensis* strains were recognised in cultures, the prominent among which are designated as types D, E, F, G and H. The cultural characters are described below:

1. *Type D.*—The texture of colony is loose. The aerial mycelium is sparse and translucent during the first week. The slimy masses of conidia are abundant covering 50 per cent. or more of the surface of the medium. In conical flasks and petri-dishes the concentric depressions are full of conidia. The number of acervuli on the rind is more than in other types.
2. *Type E.*—The aerial mycelium is of velvety texture and profuse with scanty

production of conidia. Slimy masses of conidia are sparsely distributed covering about 25 per cent. of medium.

3. *Type F.*—It forms cottony growth of mycelium which turns grey with age. The conidial masses which are dark grey at first change into pink masses.
4. *Type G.*—The aerial mycelium is dark grey and profuse. Slimy masses of conidia are sparse.
5. *Type H.*—The colony is loose and silky, aerial mycelium during first two weeks almost translucent with abundant dark pseudopycnidial masses; slimy masses of conidia on the surface of the medium.

The behaviour of Co. 453 when tested with 'Type D' is quite different. The average length of infection (the spread of the parasite in the standing canes) is 27·7" and the longest recorded is 106" which exceeds the previous records of Co. 210, Co. 213 and Co. 299 with 'Type B' by a few inches.

The linear spread of infection in 30 days after inoculation is noted in Table I.

Sl. No.	Type	Linear spread of infection in inches	No of internodes infected
1	D	27·7	5·4
2	E	17·9	3·6
3	F	12·0	3·0
4	G	11·3	2·3
5	H	11·8	2·5

Of the five isolates the 'Type D' is the most virulent and is a new strain; F, G and H are closely allied to 'Type B', while E appears to be an intermediate form.

The results of the susceptibility tests measured by linear spread of infection in 30 days after inoculation, are given in Table II for a few varieties with 'Type D'.

The varieties are graded into four main classes according to the linear spread of infection in cane tissues.

TABLE II
Varietal susceptibility tests

Sl. No.	Variety	Linear spread of infection in inches with 'Type D'	No. of ieternodes infected	Linear spread of infection in inches with 'Type B'
1	B.O. 3	22·1	5·1	4·6
2	B.O. 10	7·4	1·9	4·1
3	B.O. 11	6·9	1·7	4·6
4	B.O. 15	4·1	1·3	6·6
5	B.O. 17	8·9	2·0	4·6
6	B.O. 24	22·9	4·8	7·7
7	Co. 299	30·1	6·1	36·9
8	Co. 313	15·4	3·9	10·8
9	Co. 331	34·4	12·5	20·9
10	Co. 383	16·8	5·7	5·9
11	Co. 453	27·7	5·4	4·6
12	Co. 513	13·6	2·9	13·5
13	Co. 557	38·3	8·5	29·4
14	CoK 29	15·2	4·0	10·4
15	CoK 32	16·8	4·3	11·0

CLASS I.—Resistant—The infection is confined to the internode inoculated—linear spread 6" and less B.O. 15.

CLASS II.—Less susceptible—The infection is confined to the internode inoculated and the adjacent internodes—linear spread of infection 6" to 12". B.O. 17, B.O. 10, B.O. 25 and B.O. 11.

CLASS III.—Susceptible—The infection is confined to 5 or 6 internodes—linear spread 12" to 20". Co. 313, CoK 30, CoK 29, Co. 313, Co. 513 and B.O. 27.

CLASS IV.—Highly susceptible—linear spread of infection exceeds 20". Co. 557, Co. 331, Co. 299, Co. 453, Co. 622, B.O. 24 and B.O. 3.

The conditions that favour variations in the parasite are under investigation.

Central Sugarcane Research Station, Pusa, Bihar,
S. A. RAFAY.
September 20, 1950.

1. Rafay, S. A. and Padmanabhan, S. V., *Curr. Sci.*, 1941, **10**, 1, 25-26.

SYMPOSIUM ON RECENT ADVANCES IN BIOCHEMICAL TECHNIQUE

UNDER the joint auspices of the Society of Fermentation Technologists, India, the Society of Pharmacology and Experimental Medicine and the Association of Food Technologists, a SYMPOSIUM ON RECENT ADVANCES IN BIOCHEMICAL TECHNIQUE will be held in the premises of the Indian Institute of Science during the impending Science Congress week. The symposium will include a discussion of subjects pertaining to the application of radioactive and heavy isotopes in the study of intermediary metabolism, chromatographic analysis, physico-chemical methods, spectrophotometry, microbiological and biological assays.

Dr. A. Srinivasan, Dr. P. R. Venkataraman, Bombay, Dr. P. S. Sharma, Madras, Dr. V. N. Patwardhan, Coonoor, Dr. N. N. De, Dr. S. S. De and Mr. V. S. Govindarajan, Bangalore, are expected to participate in the proceedings of the symposium.

The symposium will be followed by a demonstration of the equipment employed in such studies. A detailed programme of the symposium will be issued in due course.

REVIEWS

Analytic Geometry. By R. D. Douglass and S. D. Zeldin. (McGraw-Hill Book Co., Inc.), 1950. Pp. ix + 216. Price $ 2·75.

This book is specially written for the class of students who have had no systematic training in analytic geometry and who would make a rapid study of the subject before taking up a course in calculus. The main topics treated in the book are the conics and conicoids. In the study of the conics it is interesting to find that the ellipse and the hyperbola come immediately after the circle and that the parabola comes last. The concept of the directrix is used in the case of the parabola but not for the ellipse and the hyperbola. Some standard curves are traced and the use of polar co-ordinates and parametric representation in the study of curves is illustrated. There is a good collection of exercises answers to which are provided at the end. The printing and get-up of the book are excellent. The graphs and the tables are welcome additions to the lucid explanations of the text. One wishes the book were a little bigger and packed with more information about curves and surfaces.

V. V. N.

Advances in Colloid Science, Vol. III. Edited by H. Mark and E. J. W. Verwey (Interscience Publishers, Inc., New York), 1950. Pp. xi + 384. Price $ 7·50.

This volume contains articles from eminent experts on the following subjects: (1) Atomic Forces and Adsorption; (2) Surface Chemistry and Colloids; (3) Quantitative Interpretation of the Electrophoretic Velocity of Colloids; (4) Lyogels; (5) Ultracentrifugal Sedimentation of Polymolecular Substances; (6) Fatigue Phenomena in High Polymers; and (7) Flotation.

In the first article we have an interesting discussion on the nature of non-polar and polar van der Waals' forces and the collaboration of the various attraction forces in adsorption of single atoms and molecules. The order of magnitude of such adsorption energy is 10 Kcal/mole. When, however, an ion is adsorbed on an ionic or metal surface, coulomb and induction forces come into play and adsorption energy may increase to 50 Kcal./mole, as in the case of a single cesium ion on a tungsten metal surface. One wishes that more space had been devoted to the treatment of multi-molecular adsorption layers with special reference to the work of Brunauer, Emmet and Teller.

In Article 3, an interesting section deals with Henry's attempt to solve the contradiction between the theories of (1) Smoluchowski, which is based on the assumption that a charged particle is non-conducting and has a surface which is large compared to the extension of the double layer, and (2) of Huckel, who extended the theory of conductance of ions to that of charged colloidal particles.

In Article 5, the use of the ultra-centrifuge to study of high polymers with special reference to the sedimentation properties of thread-like molecules has been discussed. Many of the unexplained facts regarding the dependence of sedimentation velocity on concentration and the effects of polymolecularity have been brought to light and problems awaiting solution have been suggested.

In Article 6, the possibility of developing a general law of fatigue for rubbers in respect to the dependence of fatigue life upon the minimum dynamic strain has been discussed and the bearing of this type of work on examination of non-rubber polymers has been indicated.

The seventh chapter on Flotation gives a very readable account of the up-to-date work on this subject of great technical importance. The technique has developed so far that it is now possible even to separate solid particles of sylvite (KCl.) from solid particles of halite (NaCl).

The book is a storehouse of information which will be very useful to investigators who are interested in these special branches of colloid chemistry.

J. C. G.

Physical Methods in Chemical Analysis, Vol. I. Edited by W. G. Berl. (Academic Press, Inc., Publishers, New York), 1950. Pp. xiii + 664. Price $12·00.

Notable advances have been made in recent years in the development of techniques for the chemical analysis of substances. Of particularly great interest and service are those methods of quantitative analysis which have to be resorted to in cases where the substance to be analysed is available only in merest traces, which may not also be destroyed during analysis; or consists of a mixture of closely related chemical

compounds which do not admit of being easily separated by simple physical or chemical means. For such analyses, analytical tools of extreme delicacy based on physical principles have been evolved, and the use of these is the job of the specialist. An analyst of today, if he is to be in a position to use these tools, must be well grounded in the basic principles of the different physical methods that have come into vogue. It is for the understanding of these basic principles that the book under review is intended. Indeed, the editor and publishers of this volume have to be congratulated on having been able to obtain contributions from reputed authorities on each subject. The title of each chapter with the name of the contributor is given below:

Absorption Phenomena in X-rays and γ-rays (16 pp.), Clarke; X-ray Diffraction Methods as applied to Powders and Metals (88 pp.), Davidson; X-ray Diffraction as applied to Fibres (70 pp.), Howsmon; Electron Diffraction (26 pp.), Brockway; Spectro-photometry and Colorimetry (61 pp.), Brode; Emission Spectrography (77 pp.), Shermann; Infra-red Spectroscopy (71 pp.), Nielson and Oetjen; Raman Spectra (17 pp.), Hibben; Polariscopic Methods (53 pp.), West; Refractive Index Measurement (46 pp.), Tilton and Taylor; Electron Microscopy (49 pp.), Heidenreich; Mass Spectrometry (51 pp.), Washburn.

This book is by no means a handbook of chemical analysis, but provides the highly necessary introduction to the various methods of analysis. The theoretical basis of each method is given briefly, (sometimes perhaps a little too briefly) at the beginning of each chapter. The methods of handling the most modern types of apparatus are described and their broad fields of application also dealt with in sufficient detail. In a book of this type, it would be unfair to expect a large amount of experimental detail for the practical worker in any particular field. Even in this respect, some of the articles, especially those on X-ray analysis, spectrophotometry and refractometry are fairly comprehensive. Each chapter contains an extensive bibliography which would be invaluable to the practical analyst.

An example of the stupendous power of some of the new methods dealt with would perhaps be not out of place here. X-ray absorption techniques have made it possible today to estimate quantitatively (without destroying the specimen) the amount of phosphorus, calcium, oxygen and nitrogen in tissues only 2μ thick and area $10\mu \times 10\mu$; the actual weights of substances involved being of the order 10^{-9} to 10^{-12} gm.!

The book conforms to the high standards usually associated with most American scientific publications and contains very few misprints. [The only two which the reviewer came across were, "crystallite" to be read as "crystalline" (page 30, line 18) and the wrong caption to figure 7 on page 549.] The reviewer warmly recommends this book to all those who are interested in the recent advances made in physical methods of chemical analysis.

S. RAMASESHAN.

Soils, Their Physics and Chemistry. By A. N. Puri. (Reinhold Publishing Corporation, New York), 1949. Pp. xiv + 550. Price $7·00.

This book is a valuable contribution to the subject of Pedology or Soil Science which, according to the author, may now be considered to have attained the status of an independent branch of human knowledge. The book embodies mainly the author's own researches on soils over a period of nearly twenty-five years.

The book is divided into three parts: Chemistry of the Soil, Mechanical Analysis of Soils and Soil Moisture. There are 242 tables and 182 figures and graphs embodying the author's own data on which his conclusions are based. The author has endeavoured to show that the bewildering lack of coherence in the mass of accumulated data on soils is only apparent, but that, when studied without prejudice, the data are capable of being reduced to simple generalisations as with other sciences.

In the first part, the soil is conceived as being made up of a framework of hydrated ferro-alumino-silicates whose suspension in water behaves like any other weak acid. It decomposes carbonates and sulphides, neutralises alkali, hydrolyses esters and inverts sucrose. Natural soils are merely mixtures of saloids of this soil acidoid. Starting with these elementary concepts, the author has very successfully explained the complicated phenomena associated with soils in the simple language of acidimetry and alkalimetry.

In the second part on Mechanical Analysis, data are presented to show that maximum dispersion of particles is attained when the soil is converted into a Na-saloid at pH 10·8. The active mass per unit volume as calculated from these primary particles agrees fairly well with that obtained by chemical means.

In the last part on Soil Moisture, the author expounds the theory that all soil moisture is capillary moisture and its distribution and

movement can be explained by the phenomena of surface tension. With this basic assumption, the author calculates from the size distribution of the capillaries and the solid geometry of particles, the complete mechanical analysis of a soil and verifies it by direct determination.

A few apparatus devised by the author and some methods of analysis developed by him are also described. There are few references and there is no bibliography, not even of the author's own papers. No attempt is made to review any of the existing theories regarding the various soil phenomena as the author believes that they may confuse the novice for whom the book is written.

It is the first authoritative text-book on soils written by an Indian and abounds in data on Indian Soils. Readers in this country will, therefore, feel quite at home while going through this book.

N. N. N.

CHEMOTHERAPY OF TUBERCULOSIS*

The proceedings record the results of an investigation conducted under the auspices of the Medical Research Council of Ireland.

Having noted the inhibitory effect of the soluble diploicin derivatives on the growth of tubercle bacilli *in vitro*, in fairly high dilutions, the authors have tried to produce a number of derivatives of diploicin of high biological activity and suitable for parenteral administration to experimental animals. Mode of synthesis of a number of these compounds is described in No. 7, but none of these compounds exhibited antitubercular properties.

No. 8 of the proceedings gives some idea of the antitubercular properties of a number of diphenyl ether derivatives. To this class belong many substances of well known antitubercular power *in vitro*, like the 4 : 4'-diamino-diphenyl sulphone and its derivatives. They have found high biological activity in those amino-diphenyl ether derivatives in which the NH_2 group occupies the position para- to the oxygen bridge and that the activity is comparatively low in the ortho-amino compounds; while in halogenated diphenyl methane derivatives containing a phenolic hydroxyl substituent, high activity has been found to be associated with molecules in which the hydroxyl group occupies the ortho- or para-position to the methylene bridge. No definite relationship could be deduced between the hydrophylic or the hydrophobic character of the linkage and activity. Final conclusions as to the relationship existing, in these related series, between constitution and antitubercular activity is not yet possible.

M. SIRSI.

Daily Fish Supply in S.-E. Asia Below People's Needs. *F.A.O. Bulletin*, Vol. V, No. 2, July 1950.

The July Number of the *F.A.O. Bulletin* contains a scientific medley of information useful to the peoples of South-East Asia in general, and of India in particular. It includes, amongst others, facts relating to fish supply, hybrid rice breeding, weed control by growth-regulating substances, control of foot and mouth disease of cattle, improvement of livestock under tropical and sub-tropical conditions, standardisation of timber classification, and the issue by the F.A.O. of the new bi-monthly booklet entitled *World Fisheries Abstracts*. In a short review, it is possible only to refer to topics of urgent interest in this country, namely, rice and fish production.

The present production level of fish in South-East Asia meets only a third of the normal protein food needs of its teeming millions, and the F.A.O.-sponsored Indo-Pacific Fisheries Council has therefore before it a programme of increase in size and quality of the fish-catch and of the bettering of the living conditions of the people engaged in fishing. This programme will include, (1) introduction of new methods and equipment; (2) collection of scientific information concerning the resources; (3) standardisation of measurements and techniques used in scientific investigation and (4) study of fish culture with special emphasis on the effect of transplanting species from one area to another.

The *World Fisheries Abstracts* is printed in such a way that a card index can be prepared out of a file of Abstracts and is designed to provide to the investigating fisheries specialists a key to the great volume of important technical material being published in their field, which in due course will serve as an encyclopædia which can be constantly kept up to date.

The hybrid rice breeding programme is part of a large and comprehensive project for South-East Asia initiated about a year ago by the International Rice Commission, and involves crossing varieties of India and Japonica groups of rice at the Central Rice Research Institute of the Government of India at Cuttack, Orissa State, to secure varieties which will combine the

*Proceedings of the Royal Irish Academy, Vol. LIII, Section B, Nos. 7-8, Vincent C. Barry and Dermot Twomey.

best qualities of each group. After the seed from the crosses is harvested, it will be sent for testing to the countries from which parent stocks were received. One of the advantages of hybridization is that through selection and crossing a variety may be produced which meets the particular needs of a certain region. Low rice yields in South-East Asia countries appear to be due to a variety of causes, *e.g.*, (1) poor fertility conditions under which rice is grown; (2) limitation of varieties used for planting; (3) susceptibility to plant diseases and to attacks by insects, and it has been estimated by F.A.O. experts that in South-East Asia countries yields of rice may be expected to increase fifty per cent. by the use of good seed varieties alone.

H. SRINIVASA RAO.

Introduction to Electricity and Optics. By N. H. Frank, Professor of Physics, Massachusetts Institute of Technology. Second Edition. (McGraw-Hill Book Co.), 1950. Pp. xi + 440. Price $5.

In this book emphasis is throughout laid on the theoretical side and as such the logical mathematical presentation gets proper scope though no knowledge of advanced mathematics is called for. The presentation is clear and sufficiently detailed and is very adequate for any one desiring to appreciate the full significance of the theoretical structure without great effort. The author wishes to consider the book as an elementary text.

The book is divided into two parts. All the four electromagnetic vectors, E, D, B and H of Maxwell's equations are introduced from the very outset in a general form, retaining their validity both for empty space and in the presence of material bodies. The second half encompasses the electric and magnetic properties of matter and is based essentially on the electromagnetic waves in dielectrics, thus smoothly leading to the subject of optics. Physical optics is well emphasized.

The newer system of units, metre, kilogram, second is introduced from the beginning along with the electrostatic and electromagnetic units and the advantages of the M.K.S. system are well brought out. The student is also made familiar with the older Gaussian units without which his understanding of much of the literature would be seriously handicapped. In the present edition, the M.K.S. has been further modified by rationalizing, i.e., by getting rid of the factor 4π. There are altogether 20 chapters. Dispersion and Scattering, Interference, Diffraction and Heat Radiation are dealt with in the last 100 pages of the book. Needless to emphasize that the get-up and binding are excellent.

B. DASANNACHARYA.

INTERNATIONAL CONGRESS OF MATHEMATICIANS

THE Congress was held at Harvard University, Massachusetts, U.S.A., from 30th August to 6th September, 1950, under the presidency of Prof. O. Veblen. About 2,500 delegates from forty-six countries attended it. Six delegates from India took active part in the Conference, and read papers in various sections. They were B. R. Seth, R. C. Bose, S. N. Roy, S. D. Chawla, K. Chandrasekhar and S. Minakshisundaram. (Dr. S. S. Pillai, who was on his way to the Conference met with a tragic death in the T.W.A. air crash near Cairo.)

The two field medals, awarded at each Congress for outstanding research work, were received by L. Schwartz and O. Selberg. Prof. Hadamard was nominated as Honorary President of the Congress.

About four hundred papers were read in the various sections.

Addresses on special topics included the following:—

H. Hopf—Die n-dimensionalem spharen und projecktiven Raume in der Topologie. H. Cartan—Sur les fonctions analytiques des variables complexes. R. L. Wilder—The cultural basis of Mathematics. S. Bochner—Laplace operator on manifolds. A. Well—Number theory and Algebraic Geometry. A. Wald—Basic ideas of a general theory of statistical values. H. Davenport—Recent work in the geometry of Numbers. There were also special conferences on Algebra, Analysis, Applied Mathematics and Topology.

SCIENCE NOTES AND NEWS

1851 Exhibition Scholarship

The Royal Commissioners for the London Exhibition of 1851 will award in 1951 one science research scholarship to students from Indian Universities or Institutions having post-graduate Departments of Science. The value of the scholarship is £350 per annum and it is tenable for a period of two years to enable the selected student who has already completed a full University course and whose record gives evidence of capacity for original scientific investigation to devote himself or herself to post-graduate research in some branch of Pure or Applied Science at any Institution abroad approved by the Commissioners.

Subjects of the Indian Union below the age of 26 on May 1, 1951 are eligible for this scholarship. Applications from students whether residing in India or abroad have to be recommended by the authorities of a University or an Institution who should forward them so as to reach the Secretary, Ministry of Education, Government of India, New Delhi, not later than January 22, 1951.

Full particulars about the scholarship and the prescribed application forms can be obtained from the Registrars of the different Indian Universities or from the Ministry of Education (Section S-3), Government of India, New Delhi.

Turkish Scholarship for Indian Students

The Government of Turkey have offered one scholarship to an Indian student for study at a University in Turkey for a period of two years commencing from early next year. The value of this scholarship is TL 117·60 per month (equivalent to Rs. 200), besides exemption from payment of tuition and examination fees. The selected scholar will have to bear the passage charges both ways and also provide for his incidental and other expenses including medical charges, travel, etc.

The subjects which a student from India can take are Turkish Language, Literature, History and Philosophy. Full particulars about the scholarship and prescribed forms of application can be obtained from the University concerned or the Central Ministry of Education.

Teterboro School of Aeronautics

In June 1950 the Teterboro School of Aeronautics, New Jersey, U.S.A., offered to the Indian students four scholarships in Aeronautics. The awards have been made to Messrs. Krishna Dev Merwaha, T. S. Srivastava, K. P. Dadlani and N. N. Batra. No more applications on this account will be entertained either by the Government of India or by the Teterboro School.

Dr. B. R. Seth

During his recent stay in the U.S.A. as Visiting Professor of Mathematics, Dr. B. R. Seth delivered a course of lectures on Elasticity, Hydrodynamics and Aerodynamics. He also participated in the Symposium arranged by the American Mathematical Society in the University of Michigan, being one of the principal speakers. He represented the University of Delhi and the Calcutta Mathematical Society at the International Conference of Mathematicians held at Cambridge, Massachusetts and took an active part in the International Conference on Fluid Mechanics which preceded it.

Industrial Research Laboratory, Devlali

An Industrial Research Laboratory is being established on a semi-commercial basis at Devlali, near Bombay, under the Directorship of Mr. N. P. Gandhi, formerly Professor and Head of the Department of Mining and Metallurgy at the Banaras Hindu University. The laboratory is to have equipment for chemical analysis, metallography, pyrometry, heat treatment and mechanical testing of metals and alloys (both ferrous and non-ferrous) testing fuels, furnaces and refractory materials, examining minerals, rocks, ores, waters, etc., and is intended to be a self-supporting Institution. The profits would be utilised for meeting the cost of research work which may be undertaken free-of-charge and for expanding the scope of its activities.

Award of Research Degrees

On the recommendation of Boards of Examiners consisting of Sir S. S. Bhatnagar, F.R.S., Prof. J. W. Smith, F.R.S. and Prof. S. S. Joshi; and Prof. H. S. Taylor, F.R.S., Prof. H. W. Melville, F.R.S. and Prof. J. W. McBain, F.R.S.,

the Banaras Hindu University conferred the D.Sc. degree on A. Joga Rao for his thesis on "H_2, O_2, Reaction under Electrical Discharge and Electro-Chemistry", and the Ph.D. degree on H. J. Arnikar for his thesis on "Study of Joshi Effect and Corona Pressure Phenomena".

University of Travancore

Dr. P. V. Nair, Professor of Applied Chemistry, has been appointed Director of Research in the University of Travancore in the place of Dr. C. C. John who has accepted service under the Ceylon Government.

Photostat Service Unit at Kasauli

The Indian Council of Medical Research have microfilm service units at the Central Research Institute, Kasauli, and at the Tata Memorial Hospital, Bombay. The microfilm service has now been augmented by the setting up of a Photostat Service Unit at Kasauli.

Requisitions for photostat copies could be marked "PHOTOSTAT SERVICE" in block letters, to avoid any confusion with requests for microfilming work, and addressed to: The Officer-in-Charge, I.C.M.R. Microfilm Service Unit, Central Research Institute, Kasauli.

Symposium on the Origin and Distribution of Cultivated Plants in S.-E. Asia

The Indian Society of Genetics and Plant Breeding, with the co-operation and assistance of the UNESCO South Asia Science Co-operation Office, is organising a Symposium on the Origin and Distribution of Cultivated Plants in the regions of South Asia. Tentative dates fixed for the Symposium are January 12-15, 1951, and the session will be held in New Delhi. The Society has already invited the workers in the field in India and the neighbouring regions to contribute to the Symposium. The plants to be discussed will include cash crops, cereals, flowering plants, spices, etc. It is expected that Dr. A. Müntzing of Lund, Sweden, an authority on speciation and genetics of wheat and rye, Dr. S. C. Harland of Manchester, the world-renowned cotton geneticist and Dr. E. Anderson of Washington, whose work on the origin of maize is a fundamental contribution, will take part in the Symposium. Dr. Müntzing is one of the invitees of the Indian Science Congress Association and the UNESCO South Asia Science Co-operation Office is arranging for the visit of the latter two scientists. From Pakistan Dr. Afzal (cotton), from Ceylon Dr. Chandraratna (rice and banana), from Malaya Prof. Holttum (orchids and spices), have so far agreed to participate.

The Symposium will be limited to the actual contributors, but observers from learned bodies and research institutions will also be invited to attend. Enquiries may be addressed to Dr. N. Parthasarathy, Secretary, Indian Society of Genetics and Plant Breeding, C/o Division of Botany, Indian Agricultural Research Institute, New Delhi 5.

Geological Survey of India

The latest number of the Records of the Geological Survey of India (Vol. 82, Part 1) gives a general report of the work done by the Survey during the year 1948. For purposes of intensive Survey work, India after the partition, has been divided into five circles each under the direction of a Superintending Geologist. The report under review gives a detailed account of the work done in each of the circles; in addition there are also elaborate accounts of work done under Mineral Investigations, Special Investigations including Geophysical Prospecting, Engineering Geology and Ground Water Investigations, etc. The report gives a good idea of the variety and volume of the work done by the Officers of the Survey. A coloured Geological Map of India indicating the field investigations carried out during 1947-48, adds greatly to the value of the report.

Forthcoming International and National Scientific Conferences in South Asia

Date	*Subject of Conference*	*Location*
1951		
Jan. 3-10	International Association for Hydraulic Structures Research.	New Delhi
Jan. 10-15	Sectional Meeting of the World Power Conference	Do.
Do.	International Commission on Irrigation and Canals	Do.
Jan. 28-Feb. 2	Indian Institution of Engineers—Annual Meeting	Bangalore

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